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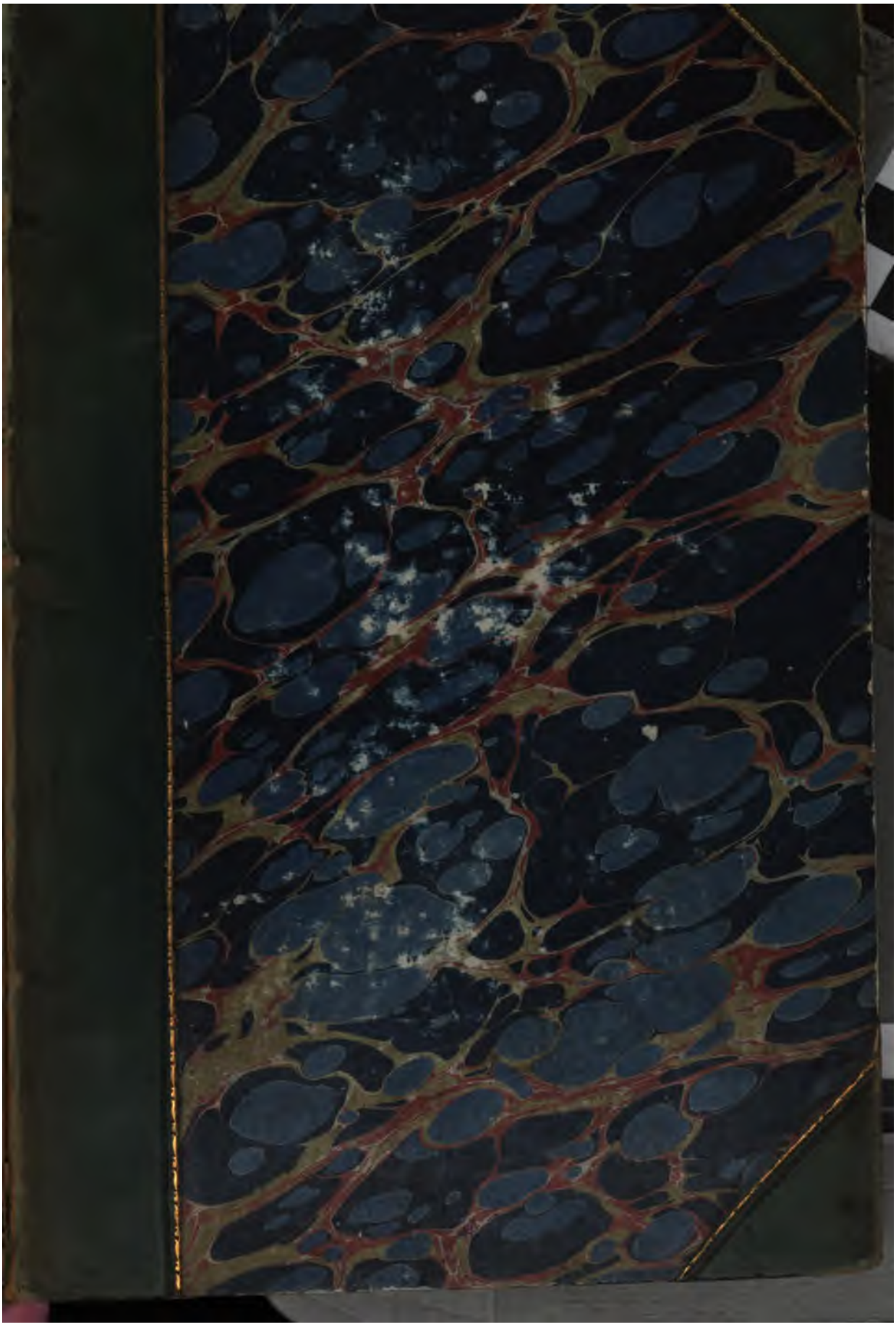
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Figures and Descriptions

ILLUSTRATIVE OF

BRITISH ORGANIC REMAINS.

DECADE XI.

TRILOBITES.

(CHIEFLY SILURIAN.)

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PREFACE.

THE plates of this Decade were engraved a year ago, but the pressure of other duties compelled Mr. Salter, the late Palæontologist of the Geological Survey, to postpone the descriptions. That gentleman has now completed the work at my request, he being at present engaged on a Monograph of all the British Trilobites for the Palæontographical Society.

Following our usual plan, those genera only have been illustrated which are rich in material for the engraver, or those which, though less perfect, are so rare and interesting as to render it desirable to publish them, even from fragmentary materials. The genus *Olenus*, characteristic of the lowest Silurian rocks of all the northern parts of Europe, is an instance in point. All the British species, save one or two, are fragmentary, but these fragments illustrate several of the important sub-genera into which this genus of the primordial Silurian of Barrande is divisible; hence a second plate of it is given. *Æglina*, pl. IV., is another case of the same kind. The genus was previously illustrated in Decade 7, from imperfect pieces of the head and body. We now possess the entire form of this genus, which is eminently Lower Silurian in its range.

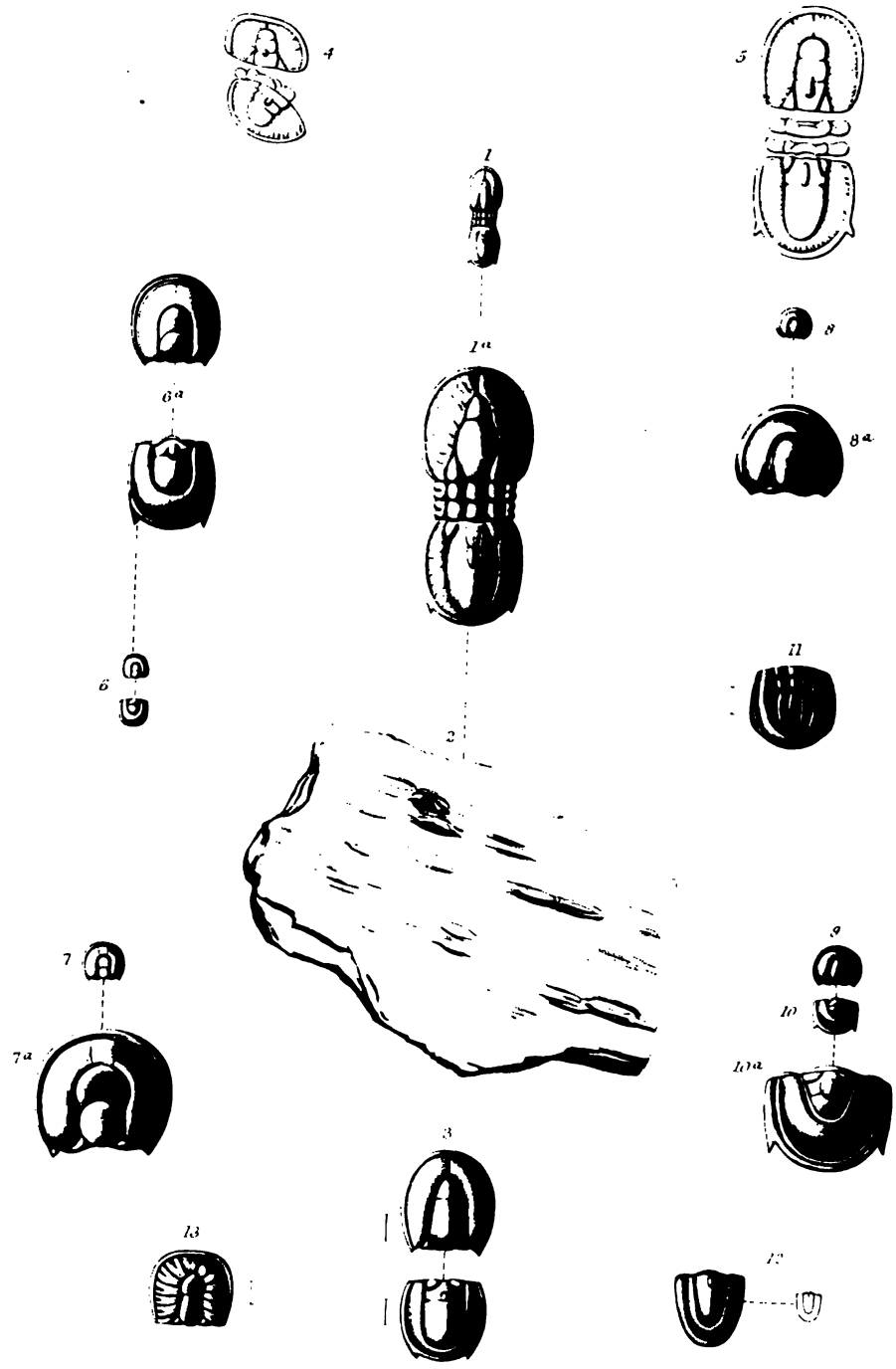
The genera *Stygina*, *Salteria*, *Trimerocephalus*, *Angelina*, *Agnostus*, and *Staurocephalus* have not before been illustrated in the Decades. *Asaphus*, before given in Decade 2 as to one of its sub-generic groups, now presents us with a British type of the sub-genus *Isotelus*, which is so common in America, but rare in Europe. Lastly, a fresh discovery, by the author of this Decade, of a gigantic *Paradoxides* in the Lingula flags of Pembrokeshire, has made it possible to figure this characteristic genus from perfect materials.

RODERICK I. MURCHISON,
Director-General.

Geological Survey Office,
28, *Jermyn Street, London,*
November 1864.

NOTE.

The reader must understand that the numerous references to Memoirs Geol. Survey, vol. iii. (ined.) throughout this Decade apply to the forthcoming Memoir on the "Geology of North Wales," by Professor Ramsay; with an Appendix on the Fossils by Mr. J. W Salter.



Figs. 1–5. AGNOSTUS PRINCEPS, *Salter.*
6. 7. —— M'COYII, *id.*
8–10. —— TRINODUS, *id.*
Fig. 11 AGNOSTUS TRISECTUS, *Salter*
12 —— SP.
13 —— MOREA, *id*

J.W. Salter direx.

BRITISH FOSSILS.

DECADE XI. PLATE I. FIGS. 1—5.

AGNOSTUS PRINCEPS.

[Genus AGNOSTUS. BRONGNIART. (Sub-kingdom Articulata. Class Crustacea. Order Trilobita. Family Agnostidæ.) Minute trilobites, with caudal and cephalic shields nearly equal. No eyes, no facial suture. Two body rings.—Ranges from Lingula flags to Caradoc rocks.]

DIAGNOSIS. *A. latus, 7 lineas longus, scutis rotundato-quadratis, ad limbum rugoso-radiatis. Glabella subconica, tuberculo centrali antico, sulcis duobus transversis, lobis basalibus magnis instructa; sulcoque verticali ad marginem ducto. Annuli corporis valde nodosi. Cauda axe magno rotundato, fere per totum caudæ extenso; margine edentulo.*

SYNONYMS. *A. pisiformis*, SALTER (1859), in Siluria, pp. 45, 53, foss. 4 and 9; *A. princeps*, id., * Memoirs Geol. Survey, vol. iii. (ined.), pl. 5.

Certainly the lowest and most rudimentary form of Trilobite, and greatly resembling in some respects the young stages of higher groups. But *Agnostus* shows at once its mature character in the possession of a large caudal shield, well developed, and generally quite as large as the head. The surface is sometimes much ornamented, especially the border, and the lobes are often well marked out both in the cephalic and caudal portions. The leading character of the Trilobite family, the facial suture, is altogether absent, and there are no eyes in any of the species.

When Brongniart described this fossil for the first time, he evidently could not tell what to make of it. To describe the head and tail as distinct animals was natural enough, but when he turned the hinder part of the head forwards, and suggested that the basal lobes of the glabella might be eyes, and the forehead lobe the abdomen, &c., one feels that he was justified in saying, "*On ne sait à quelle classe des règnes organiques le rapporter.*" Beyrich first gave the entire form in his treatise, "Ueber einige Böhmische Trilobiten," 1845.

* The reader must understand that the numerous references to Memoirs Geol. Survey, vol. iii. (ined.) throughout this Decade apply to the forthcoming Memoir on the "Geology of North Wales," by Professor Ramsay; with an Appendix on the Fossils by Mr. J. W. Salter.

It is instructive to find this, the most rudimentary form, associated with other genera in which all the characters of the group are fully developed, in the same primordial zone. But it is to be noted, that either by excessive reduction, as in *Agnostus*, or excessive multiplication of segments, as in *Paradoxides*, the genera at this early period exhibit a defective organization as compared with those of later formations. There is no sort of equality between an *Agnostus* or *Olenus* and a *Phacops* or *Phillipsia*.

The figures we give of *A. princeps* possess more than an usual interest, for they represent some of the oldest fossils known in N. Wales which occur in the lower part of the "Lingula flags," considerably below the characteristic *Linguloe* of the formation. They are in countless numbers in the black slates near the waterfall of Felyn Rhyd, near Maentwrog, and are there associated with a new *Olenus*, and with rare specimens of *Lingula*. That they are characteristic of the formation is evident from the fact that with the reappearance of black earthy slate in the upper division of the formation, the *Agnostus* reappears also in abundance, and our figure 3 is from that part of the series. In S. Wales other and new genera accompany the *Agnostus* in the lowest portions of the deposit.

Description.—Not half an inch long, though frequently elongated by pressure beyond that length. The general form of the head and tail is about two-thirds of a broad oval, truncated next the thorax, pretty regularly convex, and strongly trilobed; the thorax joints do not together occupy one-third the length of the head, and are narrower than its width.

The head is a little longer than broad, smooth, with a narrow distinct border. The glabella about as wide as the cheeks below, but tapering forwards; and divided, at more than two-thirds its height, by a transverse furrow which separates it into two parts, the lower oblong oval smooth, without lateral indentations, and the upper a spherical-triangular lobe, from the end of which a dividing line runs forward to the margin. A conspicuous pair of triangular lobes lie at the base of the glabella, in part subtending the convex cheeks, which are narrow below, broadest above, but narrower again in front, where they are separated by the dividing line.

Thorax of two nodose joints, the anterior largest. Each is strongly trilobate; the pleuræ convex, and with a strong groove toward the tips, making them appear notched (fig. 1 *a*). The axis too is trilobate, the central lobe very prominent, and strongly dis-

tinguished from the lateral and more forward portions; these are obliquely ovate,—the centre lobe is pyramidal.

Tail nearly of the same shape as the head; the margin furnished, toward its hinder edge on each side, with a prominent tooth. The axis is very broad and convex, somewhat clavate, and reaching nearly to the margin, a space the width of the latter being left between; it is of greater breadth than the sides (even including the narrow margin). The front pair of lobes are distinct, rounded-triangular, and their own diameter apart; the second pair (fig. 3, 4) occupy a less width, are not very distinctly circumscribed, and are divided from the large terminal lobe by a faint transverse furrow. The tubercle on the intermediate pair is prominent but short; it scarcely invades the terminal lobe, and is of nearly the same shape in all our specimens, however distorted.

Variations.—Our larger specimens fig. 1, 4, (fig. 5 is magnified) from the lowest and upper *Lingula Flags* have the axis of the tail rather longer and somewhat more pointed than in fig. 3, but this may be entirely due to elongation from pressure. The terminal lobe of the glabella too is shorter in proportion in the former, but there seems to be no other real difference. The rugose veins which ornament the limb are always conspicuous in well-preserved specimens, but are much obliterated in less perfect ones, as our figures will show.

Affinities.—Compared with Angelin's incorrect figures of *A. pisiformis* and *A. planicauda* (I have Swedish specimens of those species before me), *A. princeps* has the axis of the tail (though Angelin's figures have it too short) decidedly longer, and reaching so far as to leave a space, between it and the margin, of only the breadth of the latter; and the tubercle, which Angelin represents as elongated and reaching far down the middle of the axis in his *A. planicauda*, is very short and prominent in our species. In both these respects they agree better with Swedish specimens of *A. pisiformis* than with Angelin's figure; and if it were not for the longer glabella and tail axis, the larger size and the decided radiation of the limb in our fossil, we should have united ours with the well-known Scandinavian form. Our second variety β is more like it than the first and more ornamented one, α.

In size *Agnostus princeps* nearly rivals the largest of the Swedish forms, *A. reticulatus* and *A. aculeatus*, Angelin, pl. 6, fig. 10, 11. These, however, show a strong reticulation of the

surface, instead of the more or less faint radiations of the British fossil. And *A. exsculptus* (fig. 8), which is still more like ours, has no posterior spines, and a very short glabella.

We may notice two distinct varieties, possibly species.

1. *A. princeps, α. ornatus,—glabellâ fere trilobâ antice obtusâ, limbo radiato-sculpto,* pl. 1, figs. 4, 5.
2. *A. princeps, β. rudis,—glabellâ bilobâ, anticè acutiori, limbo vix radiato,* pl. 1, figs. 1, 2, 3.

British Localities and Geological Position.—Var. α. LOWER AND UPPER LINGULA FLAGS, figs. 4, 5, from Carreg Wen, near Borth, Portmadoc. Var. β. LOWER LINGULA FLAGS, figs. 1, 2, Pen-y-foel, a hill close to the Waterfall, Maentwrog, N. Wales (in great abundance). UPPER LINGULA FLAGS, fig. 3, Penmorfa Church, near Tremadoc. The species is also found in the UPPER LINGULA FLAGS (Black Shales) of Whiteleaved Oak, Malvern, where it was first collected by the late Mr. Hugh Strickland. UPPER TREMADOC SLATE, Portmadoc. LOWER LLANDEILO, St. David's Head, rare.

If I were disposed to divide the genus, as Corda and McCoy have done, the *Agnostus tardus,* Beyr., *A. glabratus,* Ang., and *A. trinodus,* Salter, would form a separate group. I prefer to regard them as forming a sub-genus only, *Trinodus,* while the species with transverse lobes to the glabella and caudal axis may stand as *Agnostus* proper, and *Condylopyge,* Corda. Lastly, the smooth forms with all but undivided caudal and cephalic shields (*A. integer,* Beyrich, *A. glandiformis,* Angelin), &c., would form a fourth division, *Phalacroma,* Corda, as follows:

Section 1. *Condylopyge,* Corda.—Glabella distinct and lobed, the forehead lobe wider than, or as wide as, the posterior ones. Ex. *A. Rex,* Barrande; *A. McCoyii, A. Morea,* Salter, &c.

Section 2. *Agnostus,* Brongn.—Glabella distinctly lobed, the forehead lobe narrower. Ex. *A. pisiformis,* Brong., *A. princeps,* Salt.

Section 3. *Trinodus,* McCoy.—Glabella not lobed. Ex. *A. tardus,* Barr., *A. trinodus,* Salter, &c.

Section 4. *Phalacroma,* Corda?—Glabella or caudal axis scarcely marked out at all. Ex. *A. integer,* Beyr. English examples doubtful.

The foregoing Species belongs to *Section* 2.—AGNOSTUS proper.

[AGNOSTUS PISIFORMIS, *Linn.*

I subjoin a description of the Swedish species, as it is necessary to show in what respects this long-known primordial species differs from the preceding, and also from the *A. McCoyii*, under which name I have designated the species common in the Llandeilo flags of Britain, and which was formerly published in the Silurian System as *A. pisiformis*.

SYNONYMS. *Entomostracites paradoxus* and *E. pisiformis*, Linn., Iter Scan. 122; Syst. Naturæ, ed. 16, vol. iii. 160; *E. pisiformis*, Wahl.; *Agnostus pisiformis*, Brongn. (1822), Crust. Foss. pl. 4, fig. 4; Angelin, (1852), Pal. Suec. t. 6, fig. 7 (*A. planicauda*, ib. t. 6, fig. 9, variety).

DIAGNOSIS. *A. elongatus, 5 lineas longus, valde trilobus, capite et pygidio ovali-truncatis, lævibus. Glabella longiconica, in duas partes, anticam trigonam parvam, posticam oblongam, divisa. Cauda axi magno, longo, lobato, apice obtuso; marginibus angustis brevidentatis.* Locality. *—Lingula flags of Sweden.*

Comparing, then, the Swedish figure with that given of our next species, it will be seen that the general shape of *A. pisiformis* is much longer, and the glabella narrower and more pointed; its upper lobe, instead of being larger than the lower, is much smaller, and from its apex a longitudinal furrow runs to the front margin. In these respects it agrees with our *A. princeps*, as before said, but differs from the Llandeilo fossil *A. McCoyii*.

There are also considerable differences in the caudal shield, as will be seen by referring to the following figures.]

Section 1.—CONDYLOPYGE.

AGNOSTUS MACCOYII.

PLATE I. FIGS. 6, 7.

DIAGNOSIS. *A. oblongus, depressus, capite pygidioque rotundatis, et ad thoracem contractis. Glabella oblonga, antice vix incrassata, in duas partes sub-æquales, posticam circularem, anticam lunatam, sulco curvo divisa. Limbus undique æqualis, lineis impressis radiatis sæpe notatus, margine angusto. Cauda capiti simillima, sed axi clavato brevi, lobo terminali majori semielliptico, mediano transverso brevituberculato, lobis anticis prominulis. Margo distinctus, brevidentatus.*

SYNONYMS. *A. pisiformis?* Murch. (1837), Sil. Syst. pl. 25, fig. 6 (fig. 4 in text), not of Brongniart; *Diplorrhina triplicata*, McCoy

(1851), Pal. Foss. Woodw. Mus. pl. 1 E., fig. 11 [not of Corda]; *Agn. McCoyii*, Salter (1854), in Morris's Catal. Brit. Foss., 2nd ed.; id., Mem. Geol. Surv., vol. 3 (incd.), pl. 13, fig. 8.

A very frequent fossil in the black Llandeilo flags of Builth, in Radnorshire, but, as far as I know, not found elsewhere. It accompanies the *Ogygia Buchii* and *Ampyx nudus*, figured in a former decade, and seems, like many others of the genus, to have delighted in a habitat of black carbonaceous mud, now converted into shale.

Description.—A minute species, never half an inch long, even when head and tail are taken together (the body rings have not yet been found). The head is rounded, not oblong, forming about two-thirds of a circle, the base being contracted where it joins the thorax. The tail is nearly of the same shape, a little more oblong. In both the convex limb is nearly equal all round, and the glabella and caudal axis are short and obtuse. The outer marginal rim is narrow but prominent all round, and the two short marginal teeth are placed far back on the caudal border.

The general shape thus given, we may notice a few details. The glabella in front is remarkably broad and obtuse, always as broad, and sometimes (fig. 7) broader than in the hinder moiety. A curved depressed line separates the front portion from the hinder lobe, and the two portions are about equal in length. The basal lobes are small and inconspicuous.

The limb is gently convex, and slopes equally on all sides away from the central lobe, from which a sharp furrow separates it all round; one or two faint depressed radiating lines occur on the limb. The margin is strong and continuous, but narrowest posteriorly, where it ends on each side with a projecting tubercle or minute spine. The small basal or neck-lobes are transverse.

Body rings unknown. (They might surely be found at Builth by collectors.) Tail of the same shape as the head, broadest posteriorly, margined all round distinctly, and with a pair of spines which occur on the sides, so far back as to be on a level with the hinder margin. The axis is short and obtuse, not reaching much above halfway down the tail, and leaving a broad equal limb. The axis is divided very unequally by a transverse line into an upper and a lower lobe, at the junction of which is the prominent tubercle characteristic of the genus. The lower or terminal lobe of the axis is as broad as long, the upper lobe twice as broad as long; a pair of minute lateral

transverse lobes at the margin of the axis lie above this, one on each side.

Locality and Geological Position.—UPPER LLANDEILO FLAGS. Builth, Radnorshire; Llandeilo, Caermarthenshire; Marrington, Wilmington, and Shelve, Shropshire.

AGNOSTUS MOREA.

PLATE I. FIG. 13.

DIAGNOSIS. *A. minor, capite radiato, radiis profundis bifidis. Glabella angusta subclavata.*

Description.—A small species, and the only one detected by Mr. Lightbody and myself in the black shales west of the Stiper stones.

It is remarkable for the strong radii on the limb, which are bisected halfway out by intermediate furrows. About seven of these principal radii occur on either side. The glabella is narrow and rather short, somewhat clavate, the sides constricted below the upper third, where the transverse furrow occurs. The basal triangular lobes are of rather large size.

Named after the Rev. J. More, of Linley Hall, under whose hospitable guidance it was found in the following—

Locality and Geological Position.—LOWER LLANDEILO (Arenig group) of Cefn Gwynlle, W. of the Stiper Stones, Linley, Shropshire.

Section 3.—TRINODUS, *McCoy.*

A. LIMBATUS.

SYNONYMS. *A. trinodus*, Mem. Geol. Survey, vol. ii. pt. 1, pl. 8, fig. 11 (not figs. 12, 13, which belong to *A. trinodus* proper), *A. limbatus*, Salter, Mem. Geol. Surv., vol. iii. (incd.) p. 41.

I only introduce the references to this imperfect fossil to complete our account, and induce collectors to pay attention to a rare form.

Locality and Geological Position.—Caradoc, Wexford. (Survey Coll.)

AGNOSTUS TRINODUS.

PLATE I. FIGS. 8—10.

DIAGNOSIS. *A. brevis, semiuncialis. Caput suborbiculare, glabellâ convexâ, nec ultra ⅔ capitis extensâ, integrâ; limbo convexo. Cauda transversa, convexa; axi minuto conico, vix dimidium caudæ efficiente; utrinque biloba, tuberculoque magno. Limbus posticus convexus, à margine bispinoso et ab axe profunde sejunctus.*

SYNONYMS. *Trinodus agnostiformis*, McCoy, Sil. Foss. Irel., pl. 4, fig. 3; in Pal. Foss. Woodw. Mus., t. 1 E., figs. 12, 13 (not fig. 11); *T. tardus*, ib., fig. 9 [*A. glabratus*, Angelin, Pal. Suec., t. 6, fig. 5].

The original figure in the Memoirs of the Survey was not quite satisfactory, for the tail segment (from decomposing limestone near Haverfordwest) had lost its axis furrows and its marginal spines. It is replaced by better specimens in our Museum from Ayrshire. The head has been found more abundantly than the pygidium, and is at once distinguished from all other British published forms (except the kindred species, *A. limbatus*) by the simplicity of its glabella, in which, and many other points, the species closely resembles *A. tardus*, Barrande.

There was a wrong reference in my first description of this species, for I quoted Professor McCoy's synonym for the *A. limbatus* next described, regarding both as varieties of the *A. trinodus*, and giving the present one the varietal name, *β. convexus*. McCoy corrected this error in the Cambridge work, where he again figured two imperfect heads of the species. I hope now to have remedied all our deficiencies by these excellent specimens, chiefly obtained by Professor Wyville Thomson from Ayrshire.

Description.—A small species, not above five lines long and three lines broad, very convex for the genus. The head and tail rounded, with a narrow equal border all round, very distinct and separated by a sharp sulcus. In the head the limb is equal in breadth in front and on the sides, separated by a sharp line from the short parabolic glabella, which has no lobes or furrows of any kind. It is a little constricted about the middle, and is rounded at its base, just above a pair of small transverse basal lobes. The posterior angles are contracted and minutely mucronate (fig. 8 *a*).

The body rings are not known.

The tail (fig. 10, 10 *a*) is semioval, the upper angles not contracted like the base of the head, but rectangular. The central lobe is

shorter than the glabella of the head, and hyperbolic rather than parabolic in outline; its breadth at base is greater than the whole length. A sharp sulcus surrounds the central lobe, which has two pairs of furrows faintly marked out; the upper ones transverse and reaching far inwards, the middle pair of furrows rather below the middle. A prominent round tubercle ornaments the centre of the lobe, of larger size than usual in the genus. The limb is very convex, and the marginal rim is broader than that surrounding the head; it has a pair of strong short spines on its outer and lower border, which are placed higher up than in *A. McCoyii* and *A. princeps*, before described.

Affinities.—There is no trace in *A. tardus* (Barr. Boh. Trilob., pl. 49) of the slight lateral indentation in the glabella, which indicates the position of a furrow. Nor are there any traces in his specimen of the lateral spines to the tail, any more than in the allied Swedish form, *A. lentiformis*, Angelin. But the *A. glabratus* of Angelin, a Caradoc form from Besstorp, in Vestrogothia, is far more like, and if I might suppose that his artist had made the form too elongate, and drawn the tail axis too large, I should consider it identical. The body rings in his species are very clearly shown (and ours should be sought for). The second ring differs a good deal from the anterior one.

Localities and Geological Position.—Haverfordwest, S. Wales; Bala and other localities in N. Wales; Shineton, near Cressage, Shropshire, &c.; Chair of Kildare, Ireland; Penwhapple Burn, &c., Girvan; Ayrshire.

Foreign.—Probably Vestrogothia (D.), as *A. glabratus*, Angelin.

Section 4.—PHALACROMA?

AGNOSTUS.—*Sp.*

PLATE I. FIG. 12.

We have only the caudal shield of a species resembling the *A. nudus* of Beyrich (more like that species than any British one). The central portion is but faintly marked out; it is, however, smaller in proportion to the limb than in the Bohemian species.

The length of the pygidium is less than two lines. It is long-semioval, the border concave, and is nearly as broad as the axis,

which is half the length of the tail, not very strongly marked out, and has a small anterior prominence.

The Caradoc or Llandeilo flag species, *A. limbatus*, Salter, is somewhat like it in the broad and somewhat duplicated border, but differs in the much smaller axis, and more backward position of the central tubercle. Our species, imperfect as it is, is distinct from and lies midway between this species and the Bohemian *A. nudus*, a primordial form.

Locality and Geological Range.—LOWER LLANDEILO (Arenig group). Tai hirion, west of Bala, collected by J. W. Salter in 1853.

Section 1.—AGNOSTUS?

AGNOSTUS TRISECTUS.

PLATE I. FIG. 11.

DIAGNOSIS. *A. caudâ subrotundâ inermi, axi longo trilobato, multisegmentato. Axis fere percurrens, latus, ad medium constrictus et tuberculatus, sulcisque longitudinalibus binis approximatis exaratus.*

Two specimens only have been sent to Mr. Tennant of this rare species. It is very like *A. princeps*, from which it differs, at first glance, by the central narrow ridge on the axis, running down throughout its whole length. It is, besides, apparently a flatter species, and has no trace of the posterior spines, but in their place a simple swelling of the margin on each side. This character is unusual.

It is a small species, the tail not being above a line and a half in diameter. It is about as broad as it is long, much rounded in outline, very slightly convex, but the flatness may perhaps be due to pressure. The axis is very broad, and the basal lobes—those next the thorax—are broader and longer than usual, and nearly equal and similar to the second lobe of the axis. The large terminal ovate lobe is longer than the other two put together. All three are deeply divided along the middle line by a pair of parallel furrows, which divides the axis into three strong lobes; hence the trivial name.

Locality and Geological Position.—UPPER LINGULA FLAGS. Black Shales of Whiteleaved Oak, Malvern. Probably not uncommon; it is a conspicuous species.

Explanation of Plate I.

Figs. 1–5. *Agnostus princeps*, Salter, specimens from various localities and in different states.

Figs. 1, 2, are from the Lower Lingula flags of Felyn Rhyd Waterfall near Maentwrog, and only show the radiations faintly. [Fig. 1. is the most perfect known, and fig. 1 *a* is the same magnified. Mus. Pract. Geology]. Fig. 2 is a piece of the compressed slate, showing the ordinary condition of the fossils.

Fig. 3. Variety from the Upper Lingula flag of Penmorfa, under the church. A small specimen, magnified. The natural size is indicated by its side.

Figs. 4, 5. Large specimens of the typical form with the radiations. Upper Lingula flag, Carreg Wen farm, near Borth, Portmadoc.

Figs. 6. 7. *Agnostus* (*Condylopyge*) *McCoyii*, Salter, from the Upper Llandeilo flag, Builth. Fig. 6 shows head and tail of a small specimen; 6 *a* the same magnified. Fig. 7 a large head, natural size and magnified. (Mus. Pract. Geology.)

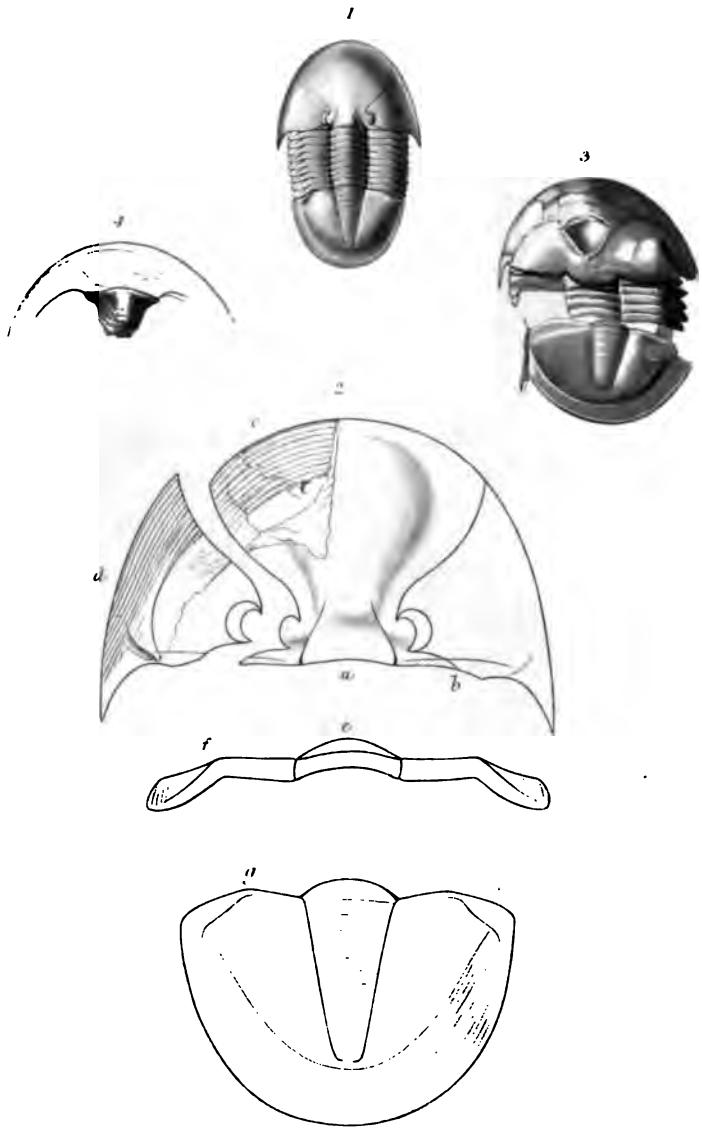
Figs. 8, 9, 10. *Agnostus* (*Trinodus*) *trinodus*, Salter. Fine specimens from the Caradoc rocks of Ayrshire, presented by Prof. Wyville Thomson to Mus. Pract. Geology. Figs 8, 9. Heads, natural size; 8 *a*, magnified. Fig. 10. Tail natural size and magnified.

Fig. 11. *Agnostus trisectus*, Salter. Upper Lingula Flags, Black Shales, Malvern. Mr. Tennant's cabinet.

Fig. 12. *Agnostus* (*Phalacroma?*) *sp.* Specimen from the Lower Llandeilo (Arenig group) of Tai hirion, W. of Bala. (Mus. Pract. Geology.)

J. W. Salter.

November 1864.



STYGINA LATIFRONS — *Salter.*

BRITISH FOSSILS.

DECADE XI. PLATE II.

STYGINA LATIFRONS.

[Genus STYGINA. SALTER, 1852. (Sub-kingdom Articulata. Class Crustacea. Order Trilobita. Family Asaphidæ.) Body ovate, flattened; head and caudal shield nearly equal; body of nine rings; eyes small, placed far backward and inward, near the base of the glabella, which is quite distinct above, and much contracted below. Facial suture marginal along a wide space in front, and below the eyes curved outward and ending on the posterior margin. No rostral shield. Labrum convex, entire. Axis of body narrow. Pleuræ without furrows. Caudal shield with a long axis.]

DIAGNOSIS. *S. sesquiuncialis, ovalis, axi angusto; spinis capitis brevissimis. Caput semiovale, obtusum, glabellâ ad basin angustissimâ, oculis retrorsis, fere ad basin capitis retractis. Cauda semiovalis, obtusa, axi subannulato.*

SYNONYMS. *Asaphus latifrons*, PORTLOCK, Geol. Rept. Londonderry and Tyrone, pl. 7, figs. 5, 6. *A. marginatus*, ib., fig. 7. *Stygina latifrons*, SALTER (1852) in Rep. Brit. Assoc. Trans. Sect. p. 59. Id. "Siluria," 1st ed. 18, and 2nd ed. 1859, p. 184, Foss. 26, fig. 2.

Among the many new and interesting forms of Trilobites described by Colonel Portlock in his work on Londonderry and Tyrone, a small species of *Asaphus* is recorded from the Lower Silurian of Tyrone, which he named *A. latifrons*, distinguishing it from some other species by the breadth of front included within the curve of the facial suture. The species is remarkable for the position of the eyes, which are placed far backward and inward, so as to be close to the base of the small and narrow glabella. This peculiarity of habit is associated with some other characters which will remove the species from *Asaphus*. The flattened oval form, long axis to the tail, and the head spines, much resemble those of *Asaphus*, from which the nine ungrooved pleuræ effectually distinguish it. In the partial obliteration of the glabella, number of body rings, and course of the facial suture, it is closely allied to *Illœnus*, from which its habit differs so much; and there is enough of the under side preserved to show there was no rostral shield, which last is an essential character of *Illœnus*.

Description.—The general form is depressed and elliptical, the length about 1½ inch, the breadth 1 inch. The contour of the head, which is exactly as long as the caudal shield, and more than one-third the whole length, is nearly a true semi-oval, evenly convex except on the median line behind (which is abruptly raised), and slopes on all sides to a concave border. The glabella, scarcely defined at all in front, though faintly indicated (more strongly so in young specimens), is of a pyriform shape. Posteriorly it is much contracted, and again suddenly expanded upon the neck border. Its greatest width behind is not above one-fifth that of the head. The eyes are small, convex, much curved, placed at less than their own length from the hinder margin, opposite the contracted part of the glabella, and rather further apart than the width of the thoracic axis. The facial suture runs out nearly at right angles beneath the eye, and in front of it describes a large arc, diverging from the eyes at an angle of 70°, and cutting the anterior border far outwards, in a line overhanging the fulcral points. The facial suture is strictly marginal in front, and the hypostome, fig. 4, appears to be quite continuous, without a rostral shield as in *Illœnus*, or a vertical suture, as in some *Asaphi*.

Two good specimens in Dr. Wyville Thomson's cabinet show the labrum, but its margin is broken off. It is wide at its attachment, considerably convex in the middle, more so than in *Asaphus*, and is marked with concentric lines on the sides. There is not enough to show that there was no marginal groove, or whether the tip was rounded and entire, as in *Illœnus*, which is most probable.

Thorax of nine rings, not so long as the head, and with its axis only two-thirds as wide as the pleuræ, convex. Pleuræ flat as far as the fulcrum, which is about the width of the axis remote from it. Thence the pleuræ are bent down and a little back, and facetted for rolling up. There is no groove whatever to the pleuræ, which thus resemble those of *Illœnus*.

Tail semi-oval, blunt, not convex, the conical axis about half the width of the sides, and reaching fully two-thirds the length of the tail. Our figure 2 *g*. has it too long. The axis has about eight faint furrows. The sides are gently convex at first, and then broadly concave, with a somewhat sharply defined margin; it is without any furrows,—even the usual upper one is obsolete, or nearly so. The apex is very blunt, more so than the front of the head. The incurved striated portion is broad, and not indented by the point of the axis.

By some accident my name is attached to this species on the plate. Our specimens are those figured and described by Portlock.

Locality and Geological Position.—CARADOC of Desertcreat, Tyrone.

OTHER SPECIES OF THE GENUS.

I only know one other British species, and no foreign ones.

S. MURCHISONIÆ, *Murch.—S. convexus, trilobus, capite longo semiovato, spinis productis. Cauda longa, axe prominulo lævi.*

SYNONYMS. *Ogygia Murchisoniæ*, MURCH., Silurian System, 1837, pl. 25, fig. 3. *Stygina Murchisoniæ*, SALTER in Siluria, 2nd ed. 1859, pl. 4, fig. 1. Morris, Catal. 2nd ed. p. 115, 1854.

Although only a single specimen of this has been found, there can be little doubt of the genus to which it should be referred. The contracted axis of the head and body, and the smooth tail with its strong axal lobe, are at all events extremely like those of *Stygina*.

Locality.—In LLANDEILO FLAGS? Mount Pleasant, Carmarthen. It is, however, probable these are Caradoc strata.

J. W. SALTER.

November 1864.

EXPLANATION OF PLATE II.

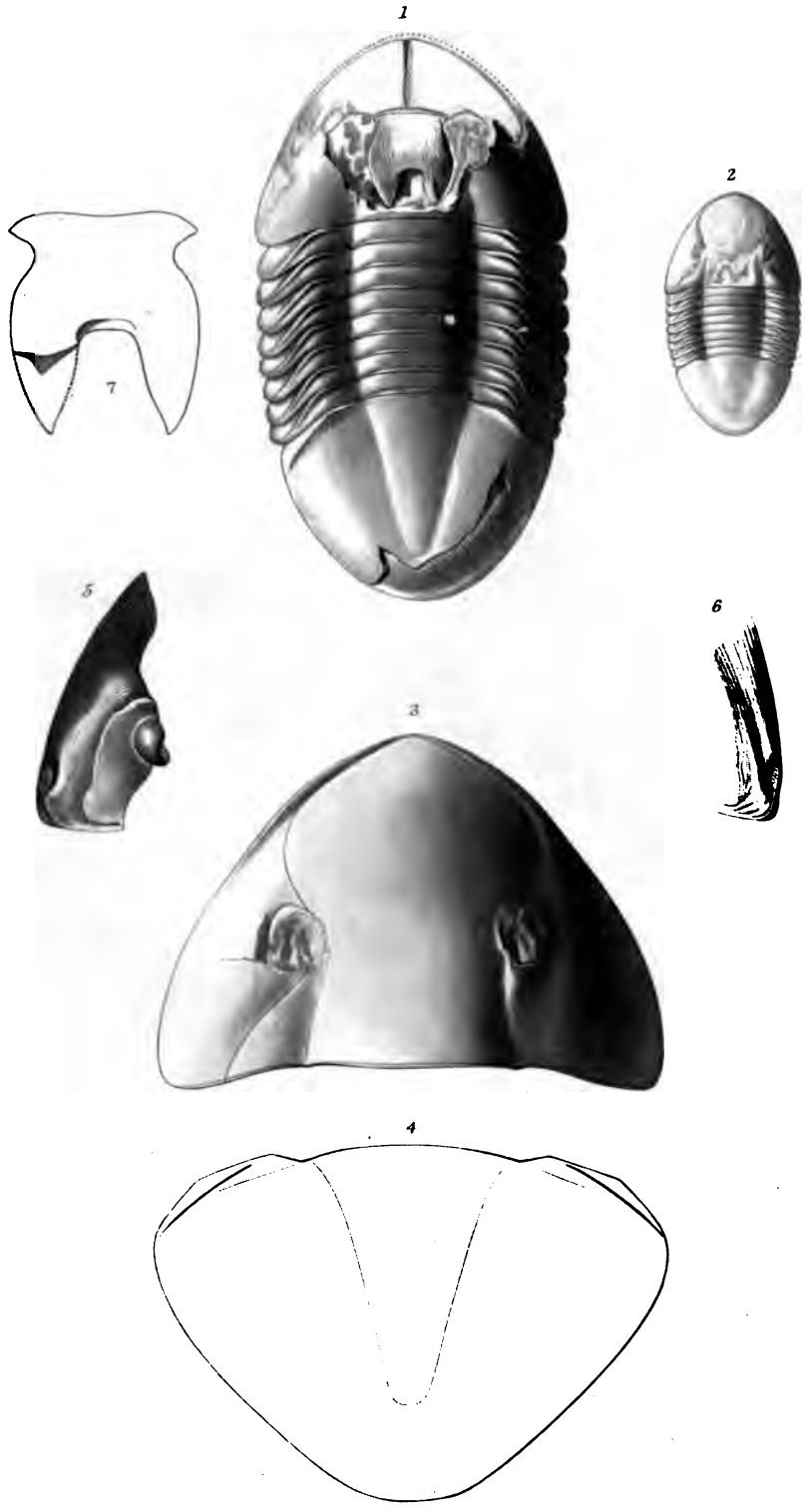
Fig. 1. Portlock's original specimen figured in the Geological Report on Tyrone.

Fig. 2. Dissected head of the same, showing obscure pyriform glabella, its base (*a*) only convex, and part of the striated incurved portion *c*, *d*, continuous with the hypostome to the short posterior angle, where it is obliquely folded. At *b*, the termination of the facial suture beneath the eye.

Fig. 2. *e*, *f*, thoracic rings of the same; *g*, tail showing the fulcrum.

Fig. 3. Larger specimen (the figured specimen of *A. marginatus*, Portl.), showing impression of the labrum *in situ*.

Fig. 4. Under surface of one of Prof. Thomson's specimens, with broken labrum showing concentric lines.



ASAPHUS (ISOTELUS) GIGAS — *De Kay*.

BRITISH FOSSILS.

DECADE XI. PLATE III.

ASAPHUS GIGAS.

[Genus ASAPHUS. BRONGNIART. (Sub-kingdom Articulata. Class Crustacea. Order Trilobita. Family Asaphidæ.) Eyes large, smooth. Facial suture marginal or supramarginal in front, and ending on the posterior margin. No rostral shield. Labrum strongly bifurcate. Body rings eight.]

[Sub-genus *Isotelus*. DE KAY. Facial suture intramarginal in front, and with a vertical suture beneath; head scarcely at all lobed; pleuræ much bent down; tail large, with faint axal furrows and no lateral ribs.]

DIAGNOSIS. *I. ovali-oblongus lævis, lateribus rectis; capite pygidioque æqualibus subtrigonis hyperbolicis. Caput sulcis axalibus minime profundis. Oculi modici pone medium capitis positi. Sutura facialis intra marginem frontalem parallela; labro * ad basin angusto, furcis longis parallelis. Thoracis axi pleuris æquali, fulcro ad tertium posito. Cauda axi indistincto angusto conico longo, limbo sulco unico superiore, reliquis nullis.*

SYNONYMS. *Asaphus platyceph.*, STOKES (1822), Trans. Geol. Soc., London, i. 8, p. 208, pl. 27. *Isotelus gigas* and *I. planus*, DE KAY (1824), Annals of the Lyc. of Nat. Hist. of New York, vol. i. p. 176, pl. 12, 13, fig. 1. *Asaphus gigas*, DALM. (1826), Palæad. 71. *Isot. gigas*, GREEN (1832), Mon. of Tril., p. 67; also *I. planus*, p. 68, *I. stegops*, p. 71, *I. cyclops*, p. 69, and *I. megalops*, p. 70. *Brongniartia isotela*, EATON (1832), Geol. Text Book, pl. 2, fig. 19. *Asaph. platyceph.* BRONN. (1835), Leth., vol. i. p. 115, pl. 9, fig. 8. *Asaph. gigas*, EMMR. (1839), Dissert. 32, 12. *Isotelus gigas*, MILNE-EDW. (1840), Crust., vol. iii. p. 298. *Asaph. platyceph.*, BUCKLAND (1840), Bridg. Treat., vol. ii. p. 76. *Asaph. platyceph.*, BURM. (1843), Org. Tril., pl. 2, fig. 12, Ray, ed. (1846), p. 110. PORTL. (1843), Geol. Rep. *Isot. gigas*, pl. 7, figs. 1–4, pl. 8, fig. 7; *I. planus*, pl. 7, figs. 2, 3 (except pl. 8, figs. 2, 3); *I. ovatus*, pl. 8, fig. 5; *I. sclerops*, pl. 10, fig. 2; *I. Powisii*, pl. 6, fig. 1. *I. megistos*, LOCKE (1842), Amer. Journ. Science, vol. xlii. p. 366; Trans. Assoc. American Nat. and Geologists (1843), vol. i. pl. 6. *I. gigas*, HALL (1847), Pal. New York, pl. 60, fig. 7; pl. 61, figs. 3, 4; pl. 62, figs. 1, 2; pl. 63. *I. gigas*, BILLINGS (1863), Geol. of Canada, p. 184, fig. 182 (and *I. platycephalus*, ib. fig. 183?)

* I prefer this term to hypostome, used in the former Decades. The hypostome of Dalman is the incurved front margin.

I have figured this fine species from General Portlock's original specimens, and I follow most writers in adopting De Kay's name, because it must have been contemporary with the publication of Stokes' paper (though the latter was read early in 1823). Even were *A. platycephalus* a little the earlier name, it was published without any description. And it is just possible that the fossil described by Stokes may belong to a different species.

Description.—General shape oval-oblong, with the sides rather straight, the head and tail nearly equal, and both subtriangular, the head pointed, the tail more obtuse at the tip. The surface is convex when the fossil has not undergone compression, a line taken from the snout to the apex of the tail being a regularly convex one, uninterrupted by any neck furrow, depression, or convexity of the smooth and even body rings, or furrows on the axis of the tail. The axal furrows are very obscure in the head; they are neatly marked but shallow along the body, and only very faint along the tail. All the surface is smooth. The sides are strongly deflected, but not steep.

The head has the shape of a broad and pointed Gothic arch, the breadth at base being to the length as three to two. The margin is very narrow and flat, rather than recurved. The facial suture forms a broad ogive arch in front, running for some distance close within and parallel to the front margin; and, beneath the eyes, which are large, placed near the glabella, and rather behind the middle of the head, the suture curves gently out and cuts the posterior margin midway from the axal furrow. The hinder angles are blunt pointed, not rounded. On the under side of the cheek near the point is a convex space, containing an oval depression, which receives the apices of the front pleuræ in rolling up (fig. 6, and see also fig. 5 for the cast of this depression on the matrix). The labrum (fig. 7) has a narrow base, then a strong constriction, and thence the sides are parallel. The apex is deeply furcate, the parallel forks occupying nearly half the entire length of the organ. Body rings smooth, rounded at the apices, deflexed at the fulcrum, which is placed rather beyond one-third, and with a broad strong groove. Tail subtrigonal, with straight sides, and rounded blunt tip. The faint axis rapidly tapering, broad conical, and reaching three-quarters the length. Sides quite smooth.

In young specimens, says Hall, the caudal extremity is more pointed, and exhibits marks of eight articulations; in older specimens these increase in number. But the crust presents many

traces of them when viewed from within; they are often distinct (Hall, l. c. 231). Burmeister also calls attention to this character. It appears to be frequent in the genus and its allies, for I have seen Swedish specimens, both of *Asaphus* and *Illænus*, which exhibited it strongly, chiefly on the axis. In like manner the lobes of the glabella often show internally, though quite obliterated on the external crust. I have not seen them in this species, but Burmeister gives them in his figure, of which he boasts the absolute accuracy. We can at least say as much for ours, so far as the specimens exhibit character; and our plate of this species is alike creditable to the artist, Mr. Bone, and the engraver, Mr. Lowry.

Variations.—There seems to be some reason to think there may be two species in the American limestones; one rarer, of broad form and with small eyes—the true *A. platycephalus* of Stokes; the other very common, of elongate form, and with variably large eyes, to which nearly all the above synonyms belong. See figures of both forms in the "Geology of Canada," 1863, by Sir W. Logan and E. Billings, p. 184. I have quoted these above. On the other hand, I should have no difficulty in referring these differences to sex, the broad *A. platycephalus* being the ♀ form.

History.—It is not necessary to refer to the American authors, who have profusely illustrated this common species. But I feel persuaded that Prof. Hall is right in uniting all Green's casts under one name; the more so as Hall had several hundred specimens at command in every degree of perfection. Prof. Green's species are chiefly due to differences of position, and in attempting too closely to identify each of these, Gen. Portlock separated the Irish specimens he described into more forms than can be now admitted. *I. gigas* and *I. planus* of Portlock he himself considers identical. *I. ovatus*, id., differs in nothing but its size; the head is really not more elongate than in his specimens of *I. planus;* and with regard to his *I. Powisii*, the more depressed form is entirely due to pressure; and the fulcrum is at the same proportional distance,—about one-third from the axis (not more distant, as stated); the appearance is due only to the before-mentioned cause. The true *A. Powisii*, Murch., has distinct ribs to the tail, square ends to the pleuræ, and a swelled glabella, but the Irish specimens all resemple *I. gigas* in these respects. I do not know that the true *A. Powisii* occurs in Ireland, while *I. gigas* is not known in England.

The large *Isotelus megistos*, which is certainly the same species with *I. gigas*, has been reconstructed in the form of a cast by

American authors, as of enormous size. The cast which is commonly sold for lecture purposes indicates a form 21 inches long; but there is no pretence for making it more than two-thirds this length. *Asaphus gigas* is not one of the largest of Trilobites.

Locality and Geological Position.—CARADOC of Tyrone (Portlock). The species ranges from Canada to Tennessee, and it is rather remarkable that it should abound in N. Ireland without reaching further to the eastward. Some other American species appear to range to Ireland, but are not otherwise members of the British Silurian fauna.

OTHER BRITISH SPECIES OF THE SECTION ISOTELUS.

2. *I. rectifrons*, Portlock, Geol. Report, 1843, pl. 9, fig. 1 *a*, *b*; also pl. 8, figs. 2, 3, 7, only referred to under *I. planus*. These belong to the head. *I. arcuatus*, ib., pl. 9, figs. 2, 3 (tail of same species). *I. intermedius*, ib., pl. 9, fig. 5.

Head semicircular convex; the angles rounded, and showing the characteristic pit for the pleuræ some distance above the angle. Glabella between the eyes about equal in width to the cheeks. Eyes large, placed much behind the middle of the head, and very much curved. Eye-line straight and directed outwards above the eye to the front margin, along which it runs. Beneath the eye it runs outwards, nearly parallel to the posterior margin. In the front of the head there is no vertical suture, the front being striate and showing rather a narrow base for the attachment of the labrum.

The tail and body Portlock called *I. arcuatus*. The body segments have the axis broader than the pleuræ, which have the fulcrum close in, and are bent back from it and rounded at the ends. The tail is wider than a semicircle; the upper angles are much bent down for the facet. The axis is marked out at its origin by two rather deep impressions, and is here rather wider than the side lobes. Thence it is not indicated, except by a slight prominence at its apex, which reaches to three-fourths the length of the tail. A broad shallow furrow beneath the fulcrum is all the marking that shows on the smooth convex sides.

Incurved portion narrow, concave; its edge not indented by the point of the axis; strongly lineate, the lines abutting sharply against the margin.

I. intermedius is too like the species just mentioned to be catalogued as distinct. It is much pressed out of shape and

obscured. But the *I. læviceps* of this author, though not the same as the *As. læviceps* of Dalman, is probably a member of the section *Cryptonymus*, a group which has the axis and glabella lobes well marked out, and often has very prominent eyes. It is very rare in England and absent in America, but is the common form of the genus in the Swedish area.

Asaphus lævigatus, Angelin., Pal. Succ., pl. 29, fig. 1, in many respects resembles *A. rectifrons*.

Locality.—Caradoc of Desertcreat, Tyrone.

3. *I. sp.* Salter, in Quart. Geol. Journ., vol. vii. pl. 8, fig. 2. A caudal portion of an undetermined species has been figured by Sir R. I. Murchison in his paper on the Silurian Rocks of the S. of Scotland. It is probably distinct from *I. gigas*.

4. ? Another is quoted in Prof. Nicol's paper on the Peeblesshire Silurians, Quart. Journ., vol. iv. p. 205, which is lost now, but was stated by myself to be allied to *Asaphus* (*Isot. megistos*) *gigas*. Both these species require further illustration; but they seem to show the gradual dying out of the American type *Isotelus* in its range eastward, as above noticed. Possibly both are referable to *Megalaspis*.

The distribution of subgenera over the northern zone is as follows:—

N. American Types.	*British Types.*	*Scandinavian Types.*
	Isotelus, rare, N. and N. West only.	[*Isotelus*, absent.]
Isotelus, common.	*Basilicus*, common, also in Mid-Europe.	*Basilicus*, rare.
	Cryptonymus, very rare, in N.W. area.	*Cryptonymus*, common.
Ptychopyge, rare.		*Nileus*, common.
		Megalaspis, do.
		Ptychopyge, do.

Explanation of Plate III.

Fig. 1. *Asaphus gigas*, De Kay, the original specimen figured by Portlock as *Isotelus planus*, De Kay. It shows the vertical suture to the hypostome and the labrum in place.

Fig. 2. Do. (Portlock's original of *I. ovatus*.)

Fig. 3. Do. (Portlock's figured specimen of *I. sclerops*.)

Fig. 4. Tail of do.

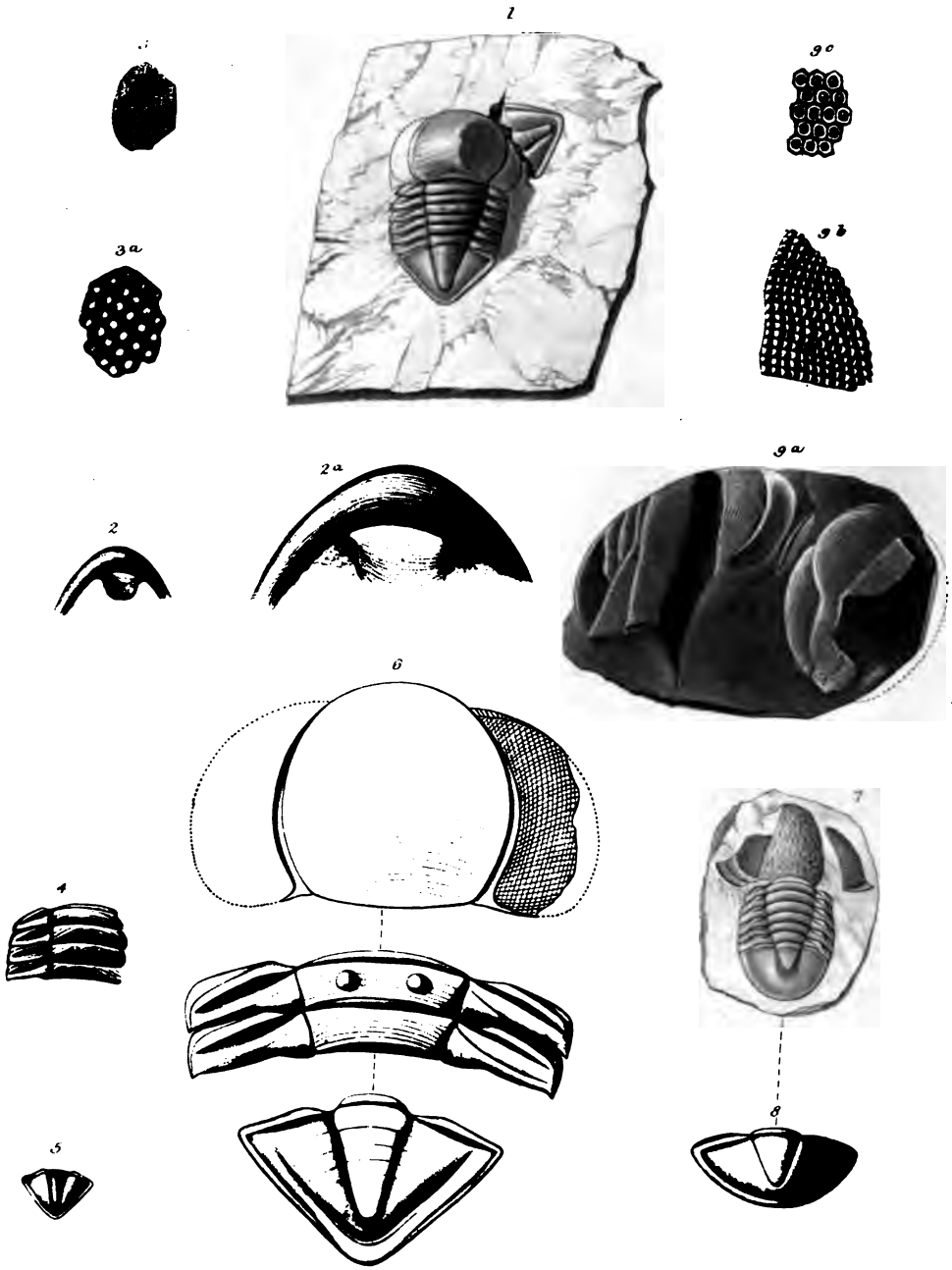
Fig. 5. Cast of under surface of side of head, showing the eye, and the pit for the reception of the ends of the pleuræ.

Fig. 6. Gutta percha cast of the same specimen, showing the real under surface.

All the above are from the Caradoc of Desertcreat, Tyrone, and are in the Mus. Pract. Geology.

J. W. Salter.

November 1864.



Figs 1–6. ÆGLINA BINODOSA – *Salter*
7, 8 —— GRANDIS ? *id.*
9 —— SP.

del.

J W Salter direx.

J W Lowry fc.

BRITISH FOSSILS.

DECADE XI. PLATE IV. FIGS. 1–6.

ÆGLINA BINODOSA.

[Genus ÆGLINA. BARRANDE, 1847. (Sub-kingdom Articulata. Class Crustacea. Order Trilobita. Family Asaphidæ.* Body oblong, the extremities equal, rounded. Head convex, glabella large, rounded or parabolic, not distinctly lobed; eyes very large, occupying the whole, or nearly the whole cheek, coarsely granulated (externally ?); facial suture ending on the posterior margin close to the axis. No rostral shield. Thorax with five or six rings, the axis broad, the pleuræ facetted and grooved. Tail large, the axis of two or three rings, abbreviated; the sides few-ribbed, or nearly smooth. *Cyclopyge*, Corda.]

DIAGNOSIS. *Æ. lata, biuncialis et ultra, convexa, capite grandi inflato, lævi; segmento thoracis tertio binodoso; caudâ triangulatâ profundè marginatâ.*

SYNONYMS. *Æglina binodosa*, SALTER, Siluria, 2nd ed., p. 50, Foss. 8, fig. 6. Id. Mem. Geol. Surv., vol. iii. ined., pl. 11 B. fig. 3.

The genus has been previously illustrated in Decade VII., but from less perfect materials.

Description.—About an inch long, and three-quarters broad in the widest part; the head very blunt in front, and the tail tapering acutely. The glabella is round and inflated; the axis of the body tapers quickly backwards, and the tail is truly triangular. These characters and the tubercles on the third body segment will easily enable the collector to identify it.

The head is seldom perfect, but, from many specimens, must have been transverse-oblong, while the glabella is perfectly round, inflated, and showing no trace of lobes or furrows. It has a narrow border down the sides, marking the course of the facial suture, and separating the glabella from the broad lunate eyes, which are coarsely granular (fig. 3) and occupy the whole cheek. As usual in the genus, the inflated glabella shows no trace of a neck segment.

* For the present I do not wish to cut up this large natural group. But a better knowledge of the primordial forms of it will doubtless render it necessary to do so bye and bye. *Æglina* has some relation to *Remopleurides* (*Olenidæ*).

Beneath the head the hypostome is continuous (fig. 2 *a*) and tumid, without rostral shield or any suture, and the convex labrum has rather a broad base, as in *Illænus*.

The thorax is convex, and has a wide and much tapering axis, broader than the sides. It is greatly wider in front than its pleuræ, and behind is not quite so wide as these. Its rings are gently arched, and the third one bears a pair of those enigmatical tubercles which are of so common occurrence along the central lobe of Trilobites.* The front pleuræ are very short, and the hinder elongated. They are more curved forward than our figure indicates, at least in the central and hinder rings. The fulcrum is near the axis, the groove broad, not deep; the apices truncate, and a little pointed behind. The facet is long and narrow.

The tail is truly triangular, and except that the apex is rounded off, would be an equilateral triangle, deeply and strongly margined all round, and with a narrow conical axis which reaches two-thirds and rather more of the length. Its tip is rounded, and it is marked by a single broad ring at the base, and very faint traces of two or three others.

Variations.—Young specimens, which I have seen since the plate was engraved, in the choice cabinet of Mr. H. W. Edgell, show the metamorphosis. In a specimen which is barely two lines in length, the number of rings to the body is only four, and the fourth ring is scarcely separable from the caudal shield. The axis of the latter is narrower than in full-grown specimens; but I do not see much other difference.

This is one of the most conspicuous species of the genus, and in great plenty in the black slate of one locality. It differs so markedly from all the other species, in the triangular tail with a prolonged axis, that it is unnecessary to compare it with any. It appears to have grown to a less size than *Æ. grandis* next described.

Locality and Geological Position.—LOWER LLANDEILO FLAGS (Arenig group), Cefn Gwynlle, in the district west of the Stiper Stones, Shropshire; in black slate, abundant. My friend, Dr. A. Fritsch, of Prague, tells me he has found the same species in the Lowest Llandeilo beds (d. 1) of Prague. I suppose it a closely allied, not identical, form.

* They have been specially noticed in my memoir on the *Phacopidæ*, Palæont. Transact., vol. for 1862, p. 52. And they are conspicuous under various forms in *Encrinurus*, *Cheirurus*, *Sao*, and a host of other genera. Probably they indicate the places of cutaneous glands, but their purpose is not yet evident.

ÆGLINA GRANDIS.

PLATE IV. FIGS. 7, 8.

DIAGNOSIS. *Æ. ovalis, 2-3-uncialis, depressa, tuberculatâ, axe corporis angusto; caudâ rotundatâ lævi, lateribus unisulcatis.*

SYNONYMS. *Æglina grandis*, SALTER, Siluria, 2nd ed., p. 53. Foss. 9, fig. 6. Id. Mem. Geol. Surv., vol. iii. (incd.) pl. 12, fig. 11.

Description.—Oval (rather depressed?) 1¾ inch long; head more than two-fifths the whole length, with a large glabella without lobes, covered with rather prominent tubercles. This character is so remarkable in the genus that no long description is necessary to enable us to recognize the species. The eyes are very large, as long as the head, and there appears to be a larger border beyond them than usual in the genus.

Body of six rings, the axis narrower than in most of the species, broadest in front, contracted behind, where it scarcely equals the pleuræ in width. These are bent at the fulcrum, which is placed rather more than one-third out from the axis in the front rings, and nearly at half in the hinder ones.

The tail is semicircular, and has rather a conical axis of two joints, rather long in our figure 8, which I believe is the same species. One obscure lateral furrow (the uppermost) is all that is visible on the smooth sides. A distinct margin runs all round the tail, neatly defined, but not by a broad or deep furrow. The shape of the tail in fig. 7 is much rounded, and more than a semicircle. In fig. 8 it has been compressed longitudinally, and has a shorter aspect; but I believe this is only due to compression in the slaty rock.

The largest specimen I have seen appears to have the fulcrum of the pleuræ further inwards, but agrees in other respects with the remaining specimens; at least it has the tubercular glabella, a character in which our species differs from all others.

Of the two British species previously described; *Æ. mirabilis*, Forbes, has a parabolic and lobed smooth glabella. *Æ. major*, Salter, has a wide body axis, and two lateral furrows in the tail.

All Barrande's species have a smooth glabella, and are very much smaller than ours, except his *Æ. speciosa*, which has a very broad axis and short marginal eyes.

Locality.—LOWER LLANDEILO FLAGS (Arenig group?), South side of St. David's Head, Pembrokeshire.

ÆGLINA, sp. (EYES OF).

PLATE IV. FIG. 9.

This large species is perhaps not the largest *Æglina* known; M. Barrande has an enormous one from the Llandeilo rocks of Bohemia, with a projecting front to the head. Ours probably was six inches long, and the great eyes an inch and a quarter long (no other part occurs with them). The eye of this species lay for a long while in the Museum as an undescribed *Bryozoon* from the Llandeilo flag. Contrary to the usual arrangement in the eyes, the lenses are in quincunx, instead of hexagons (see fig. 9 *b*), and very closely set; but in some parts the normal hexagonal arrangement is seen (fig. 9 *c*).

Locality.—UPPER LLANDEILO FLAGS of Abereiddy Bay, Cardiganshire. The rest of the body should be sought for there.

EXPLANATION OF PLATE IV.

Fig. 1. *Æglina binodosa*, Salter, nat. size, Lower Llandeilo (Arenig) group of Cefn Gwynlle, Stiper Stones, Shropshire.
Fig. 2, 2 *a*, magnified. Labrum and hypostome of do. Same locality.
Fig. 3, 3 *a*, magnified. Eye of do.
Fig. 4. Body rings, showing the tubercles on the third segment.
Fig. 5. Tail, nat. size.
Fig. 6. All the above portions are enlarged in this figure.
Fig. 7. *Æglina grandis*, Salter. A small specimen from the Lower (?) Llandeilo rocks of Whitesand Bay, St. David's, Pembrokeshire.
Fig. 8. A compressed tail. Same locality.
Fig. 9 *a*. *Æglina,—sp.* An enormous species, of which we have only the great eyes in their natural position. The slate is much compressed and folded. 9 *b*, *c*, magnified parts of the eye. Upper Llandeilo, Abereiddy Bay, Pembrokesh.
All the above are in the Mus. Pract. Geology.

J. W. SALTER.

November 1864.



2



1

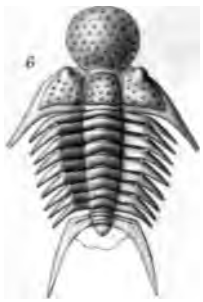
3a





3b

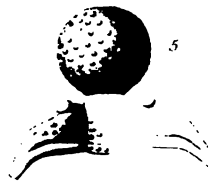




6

4a





5

4b



Figs. 1 4 (5?) STAUROCEPHALUS MURCHISONI — *Barr*

6 GLOBICEPS — *Portlock*

BRITISH FOSSILS.

DECADE XI. PLATE V.

STAUROCEPHALUS MURCHISONI.

[Genus STAUROCEPHALUS. BARRANDE, 1847. (Sub-kingdom Articulata. Class Crustacea. Order Trilobita. Family Cheiruridæ.) Head cruciform, with long clavate glabella, greatly swelled in front into a hemispheric lobe, the base narrow cylindric, with three pairs of furrows. Cheeks convex, with pedunculate eyes and serrate margin. Facial suture ending on the external margin. Body rings 10, without pleural grooves, pointed. Tail of few segments, the apices of the pleuræ free. *Barrande.*]

DIAGNOSIS.—*S. ovatus, tuberculosus, oculis remotiusculis, margini genarum spinoso. Cauda quadrata, pleuris omnibus æqualibus retrorsis parallelis, haud divaricatis.*

SYNONYMS. *Staurocephalus Murchisoni*, BARRANDE (1852), Syst. Sil. Bohème, pl. 43, fig. 28-32. *S. Murchisoni*, SALTER, in Siluria, 2nd ed. 1859, p. 540; Id., Morris's Catal., 1854, p. 115.

One of the most curious, though not most conspicuous, of our British species. The globular head, or rather glabella, set on its narrow stalk-like base, the gibbous cheeks, projecting eyes, serrate border, and spiny comb-like pleuræ and tail, combine to give an extravagant and unusual appearance to the fossil. It is seldom found perfect. But the skill of the Dudley naturalists has long been exercised on it, and specimens are now to be found in many cabinets. Mr. Hollier's specimens are the principal ones figured. Mr. Ketley has some fine ones, and our figs. 1, 2, are from the Museum of Practical Geology. They were formerly part of Mr. E. Davis's collection at Presteign.

Description.—About an inch long, of which the gibbous head occupies more than two-fifths. This is longer than broad, roughly triangular in general outline, but not truly so. It appears rather four-lobed, or like the heraldic "*fleur de lis,*" the truly globular front occupying more than half the length of the glabella, and being at least three times as wide as its semi-cylindrical base, from which it is abruptly cut off by a transverse furrow; the base is marked by two distinct lateral lobes besides the neck furrow. The cheeks reach forward about half way up this globular portion, and the

central part is necessarily raised, so as to be nearly on a level with the glabella.

The cylindrical eyes are on the most convex part of the cheeks, and are directed outwards, scarcely forwards. The margin is distinct in front of the head as a very narrow prominent ridge, and furnished on each side with about 14 truncate spines; the cheek spine is directed backwards, and but slightly outwards, abrupt at its origin, and not reaching beyond the two or three first body rings. The facial suture cuts the outer border in a direct line from the base of the eye.

All the prominent parts of the head are covered with larger and smaller tubercles; they only fail on the deeper furrows, and the truly vertical outer half of the cheeks. They are conspicuous on the border, and even on the cheek spines.

The body and tail united are slightly longer than the head, the thorax of 10 rings many times longer than the short square tail, and the axis about one-fourth the whole width, and highly convex, especially in front. There are no axal furrows to separate the gibbous axis from the horizontal portion of the pleuræ, and these soon curve downward, and are abrupt and steep on the sides.

The pleuræ are semi-cylindrical, the front portion, separated by the pleural groove being very narrow in this and allied genera, placed on the forward margin, and scarcely visible.* The apices curve much backward, and in the hinder pleuræ a little outward again, and are produced into strong spines beyond the ovate facetted portion. And all along these pleuræ and over the axis tubercles are placed at equal distances, except that the central prominent tubercle fails on alternate rings of the axis, and the intervening ones, especially the ninth, are stronger than any other tubercles, and remind us of the spines on *Encrinurus*.

The tail is nearly square, concave rather than flat, the short conical axis, of four rings, not easily distinguishable from the sides, which are composed of three flat broad spinous pleuræ directed backwards, and quite parallel, so as to give a comb-like appearance. A few tubercles are scattered on the surface.

Locality and Geological Position.—CARADOC ROCKS, near Bala, N. Wales (fig. 5); WOOLHOPE LIMESTONE AND SHALE, Corton, Presteign (figs. 1, 2); WENLOCK LIMESTONE, Dudley and Malvern.

* Yet I doubt the propriety of making this character so important in classification as Barrande has done. The pleural groove is always present in one form or another. In this case it is anterior, in *Cheirurus* it is very short and oblique.

STAUROCEPHALUS GLOBICEPS.

Pl. V. Fig. 6.

SYNONYMS. *Ceraurus globiceps*, PORTLOCK (1843), Geol. Rep., Tyrone, 257, t. i. f. 7. *Staurocephalus globiceps*, SALTER, in Morris's Catal., 2nd ed. (1857), p. 115.

DIAGNOSIS. *S. ovatus granosus, caudâ elongatâ, spinâ utrinque unicâ divergenti. Glabella stipite brevi vix lobato. Oculi approximati. Spinæ genales et pleurales diffusæ. Cauda brevis, pleuris primariis longè extensis, latis; reliquis—?*

A much smaller species than the preceding, and distinct from it by abundant characters of shape and habit. The divergent spines of head, thorax, and tail enable us at once to recognize it; and of the latter, the remarkable extended first pair of pleuræ (the rest of the tail is lost) show a near connexion with the *S.? Maclareni*, afterwards described.

Only one good specimen, 10 lines long, is known. The head is equal to the thorax in length, and longer than the caudal portion. It has a very large globular front, longer than the square stipes, and granular all over. This stalk or base seems to be without furrows. The cheeks granular, gibbous, with a prominent eye on the front edge, near the glabella, and directed forward, not outward; a broad plain margin, and widely divergent spines.

The axis of the thorax is cylindrical, and as wide as the stalk of the glabella. The pleuræ flat as far as the fulcrum, which is less remote than the width of the axis, with patent not recurved spines as long as the portion within the fulcra. The thorax tapers backward rather rapidly to the tail, which has a short three-ribbed axis, and the upper pair of its pleuræ are very much expanded, widely divergent, and more arched than in our figure, which also represents the thoracic pleuræ as less curved than they really are. The hinder portion of the tail is absent on our specimen; and I know of no other.

Locality and Geological Position.—CARADOC ROCKS of Desertcreat, Tyrone (Mus. Pract. Geology).

A third form, very abnormal in its characters, and of large size, has been named *S. Maclareni* by Prof. Wyville Thomson, after the veteran Scotch geologist, in whose company he found it. It is, however, Prof. Thomson's previously described *Aciduspis unica*. As he has mislaid his own full description, I may supply the following notes, from his specimens and others presented to the Museum of Practical Geology by himself.

STAUROCEPHALUS? UNICUS.

DIAGNOSIS. *S.* 1¼ *uncialis, oblongus, sparsè granulosus, glabellâ gibbâ eminentissimâ, corpore plano, caudâ expansâ transversâ. Caput latum, glabellâ clavatâ elevatâ frontem longè impendente, a genis punctatis distinctissimâ; margine crasso utrinque bispinoso. Pleuræ subplanæ, sulcatæ, rectæ, apicibus abruptè recurvis. Cauda lata brevis, axi appendiculato, pleuris primariis latissimis spatulatis, margine postico truncato.*

[SYNONYM. *Acidaspis unica*, WYV. THOMSON, Quart. Geol. Journ., vol. xiii. pl. 6, fig. 13.]

In the absence of a figure sufficiently complete (for the one quoted above is very defective), it is necessary to give a rather full diagnosis of this remarkable form, which tends to show the passage of the *Cheirurid* into the *Acidaspid* family. Indeed, if Prof. Thomson be correct in figuring 12 segments to the body, the species is abnormal for either *Acidaspis* or *Staurocephalus*. The shape of the head clearly enough shows that it is to *Staurocephalus*, or else to one of the sections of *Cheirurus*, that this strange fossil must be referred. *Cheirurus* often has 12 segments, *Acidaspis* 9 or 10, *Staurocephalus* only 10. The grooved pleuræ are unlike *Staurocephalus*, but like the section *Eccoptochile* among the genus *Cheirurus*. But no *Cheirurus* has so clavate a glabella, though a tendency towards it is exhibited in some species, and *Sphærocoryphe* of Angelin is very near to ours.

There is an evident analogy too in this form with *Lichas*, both in the shape of the tail and the character of the pleuræ. But the external position of the facial suture far up the cheek easily distinguishes it from that genus. I do not further describe it, as it will appear in a very early plate in the volumes of the Palæontographical Society.

Localities.—CARADOC SCHISTS, at the base of the "Orthoceratite and Graptolite flags," Penwhapple Glen, Ayrshire (W. Thomson).

EXPLANATION OF PLATE V.

Fig. 1. *Staurocephalus Murchisoni*, Barrande, coiled specimen, natural size. Woolhope Shale, Presteign. (Mus. Pract. Geology.)

Fig. 2. Head of ditto, same locality and cabinet.

Fig. 3. Magnified figures from the above specimens, completed from Dudley specimens.

Fig. 4 *a*, *b*. Magnified specimen from Dudley. Mr. E. Hollier's cabinet.

Fig. 5. Lower Silurian specimen. Rhiwlas, Bala (Mus. Pract. Geol.), nat. size and magnified.

Fig. 6. *Staurocephalus globiceps*, Portlock (his original specimen, magnified three diameters).

November 1864. J. W. SALTER.

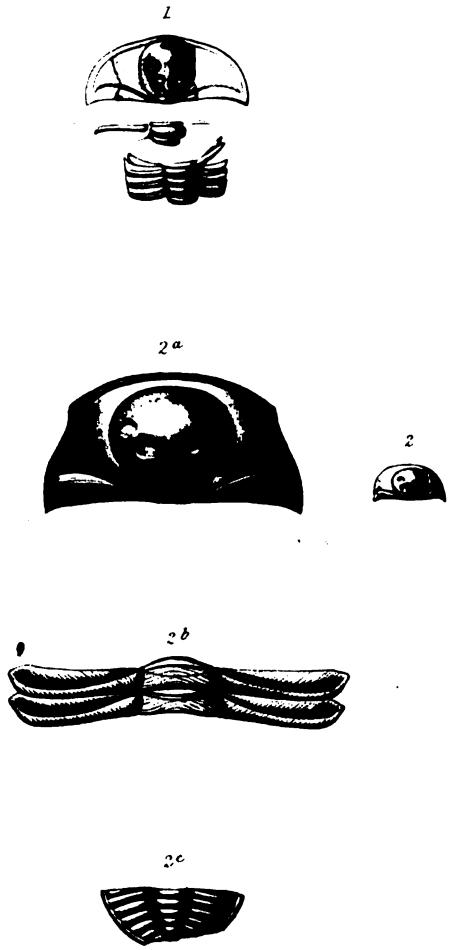


Fig. 1 2 SALTERIA PRIMÆVA — *Wyv Thomson*

BRITISH FOSSILS.

DECADE XI. PLATE VI.

SALTERIA PRIMÆVA.

[Genus SALTERIA. WYV. THOMSON. (Sub-kingdom Articulata. Class Crustacea. Order Trilobita. Family Trinucleidæ.) Body oval, tapering backwards. Head large, semi-lunar, margin very narrow, simple, surrounding a broad limb. Glabella inflated, furrowed. Facial suture following the edge, except through a small portion on either side, where it becomes nearly vertical and slightly emarginates the upper surface, cutting off a narrow free cheek. [Eyes minute, linear.] Thorax of few segments. Tail of many segments.]

DIAGNOSIS. *S. fere uncialis, lata, ovata. Caput semilunare limbo angusto brevi convexo marginato; glabellâ ovatâ pyriformi depressâ, genis multo majori, utrinque puteis tribus brevibus notatâ; sutura facialis sub fronte ambitui parallela, dein per quartam partem externam limbi conspicua subverticalis. Thorax articulis truncatis. Cauda triangularis multisegmentata.*

We have no hesitation in placing *Salteria* among the *Trinucleidæ*. It is evidently closely allied to *Dionide*, especially to Angelin's species *D. euglypta*. They have nearly the same form of glabella with longitudinal grooves; the same narrow, smooth, concave limb; the same structure of body rings and tail. The great difference between them consists in the presence in *Salteria* of a distinct though linear free cheek, and apparently of a true eye in its normal position. In these characters our fossil at once recalls *Cyphoniscus*, placed by Mr. Salter, apparently with much reason, among the *Olenidæ*. It also resembles this genus in the peculiar character of a delicate striation on the cast of one portion of the head, while the remainder is smooth. We have a specimen of *Cyphoniscus* from the same beds in Ayrshire retaining the free cheek, and showing a well marked narrow rim, ending in a long, straight, genal spine. The specimen is unfortunately too imperfect to show the eye. In *Cyphoniscus* the structure of the body rings is quite characteristic, and the small Olenoid tail is very different from the compound tail of *Salteria*.

Description.—Length of adult about three-quarters of an inch. Form broadly oval, tapering backwards. Head large, semi-lunar, slightly but regularly convex. The central shield, composed of glabella and fixed cheeks, is widely semicircular, emarginate externally, with a contour nearly corresponding with that of the head. The head is bordered by a distinct but not very broad, smooth, slightly concave margin, which is continuous with the central shield through the anterior half of the margin, but is cut away at the exterior fourth on each side by the curving inwards of the facial suture. The glabella is rounded-trigonal, in front transversely oval and very convex, and slightly prolonged and contracted behind, where it is much flattened; the crust is perfectly smooth. The two posterior glabella furrows on either side are represented by shallow pits, arranged nearly in a square, and occupying the posterior third of the glabella; the anterior pair of furrows by similar depressions more remote, placed near the anterior and outer angles of the middle third. Two longitudinal grooves connect the posterior glabellar depressions with the neck furrow, only shown in our upper figure. The tergal portion of the neck segment is small and convex. The fixed cheeks are large, slightly arched, coalescing before the glabella in a narrow ridge, bordered by a still narrower margin. The lateral portion of the occipital groove passes forwards and outwards two-thirds across the fixed cheek, then slightly backwards to the lateral margin, cutting off nearly one-third of the cheek. The portion of the cheek before the groove is smooth like the glabella, the portion behind it (the neck segment) is marked with delicate striæ parallel to the furrow and to the posterior margin.

In all our examples the free cheeks and the eyes are absent, but from the portions which we possess, and from the analogy of closely allied forms, we may safely supply a facial suture coinciding with the outer edge of the anterior margin, appearing upon the upper surface nearly midway between the centre of the frontal edge and the genal angle, passing gently inwards, and then outwards and backwards through the limb, slightly emarginating the semicircular contour of the head, and so curving downwards and outwards towards the genal angle.

The linear free cheek, bearing probably a linear eye, is absent. In our specimens the posterior angles have an imperfect truncated look, and we should be inclined to believe that, following the analogy of *Trinucleus, Dionide, Cyphoniscus,* &c., the lower edge

of the free cheek was prolonged into a genal spine. The labrum is unknown.

The body rings are few ? in number. The axis is rather wide and more convex than the pleuræ (epimerals). A deep groove passes diagonally across them, curving slightly backwards from behind the anterior and inner angle of each epimeral portion to the outer and forwards to the outer angle.* The distal ends of the pleuræ are truncated obliquely forwards.

Of the tail we have only a fragment, but enough to show that it was somewhat triangular, marked with many segments, but fewer than in the tail of *Dionide* (*Polytomurus* of Corda).

We regard the structure of the head in *Salteria* as intermediate between that of *Trinucleus* and some of the *Olenidæ*. We may expect to find a series, beginning with the distinct facial suture and crescentic eye of *Remopleurides*, then the suture gradually approaching the edge of the head, passing through its position in *Salteria*, *Ampyx*, and *Cyphoniscus*, till it reaches the edge in *Dionide* and *Trinucleus*, the eye becoming more and more linear as it approaches the margin, till when it reaches it, the suture being constantly immersed in mud, and its function in abeyance, it becomes altogether obsolete, and is sometimes replaced by stemmata ? jutting out on the epimerals of some of the other head segments.

We have much pleasure in dedicating this remarkable genus to our friend, lately the Palæontologist to the Survey.

Varieties.—The only variations which we possess of this species depend on age and size. Our largest specimen (fig. 1) may have been about an inch in length. The glabella is slightly carinated on the posterior third, and the longitudinal grooves are well marked. In smaller examples the glabella ridge is absent, and the longitudinal furrows scarcely perceptible.

Locality and Geological Position.—We procured about half a dozen specimens of the head from Schists forming the base of the "Graptolite and Orthoceratite flags," Penwhapple Glen, in the Girvan district;—the equivalents of the "Upper Bala or CARADOC ROCKS."

P. WYVILLE THOMSON.

* The groove is more forward than in our figure, so as to leave a larger posterior half to the pleuræ, but the direction of the groove is correctly given.

Other Species of the Genus.

2. In the Museum of Practical Geology there is a head of a small species with a smaller and more pyriform glabella, a wider and more deflected limb (almost involute) in front of it, and a narrow neck segment. It was not found till after the plate was engraved, or should have been added to it. It may be called

S. INVOLUTA.

Diagnosis. *S. minutus, capite vix 3½ lineas lato, convexissimo, ad frontem decurvo gibbo. Glabella pyriformis, dimidium capitis efficiens, sulcis transversis. Sulci cervicales vix arcuati. Oculi haud remoti.*

The involute limb in front is really about as broad as the width of the glabella, but is so much curved down that only a part of its breadth is seen on an upper view. The glabella, not equal to the width of the free cheeks at their base, is pyriform in outline, and marked by two pairs of transverse furrows, which indent it far inward, and one pair, the upper one, which is minute and very far outward. The furrow surrounding the glabella is very sharp and deep, but not broad. It separates an extremely tumid limb, which comprises the broad front margin and the convex cheeks. The facial suture cuts the front margin far outward, as in *S. primæva*, but, unlike that species, it then turns sharply inwards very near to the glabella, and then again abruptly outwards, in a wide curve to what must be the extreme end of the cheek.

The neck furrow is sharp and deep, and reaches nearly to the end of the facial suture. It is nearly parallel to the posterior margin, instead of curving forwards as in that species.

The species looks like a dwarfed variety of *S. primæva*, but is really a very distinct one.

Locality.—Llandeilo Flags, Newtown Head, Waterford, in the cabinet of Major Austin.

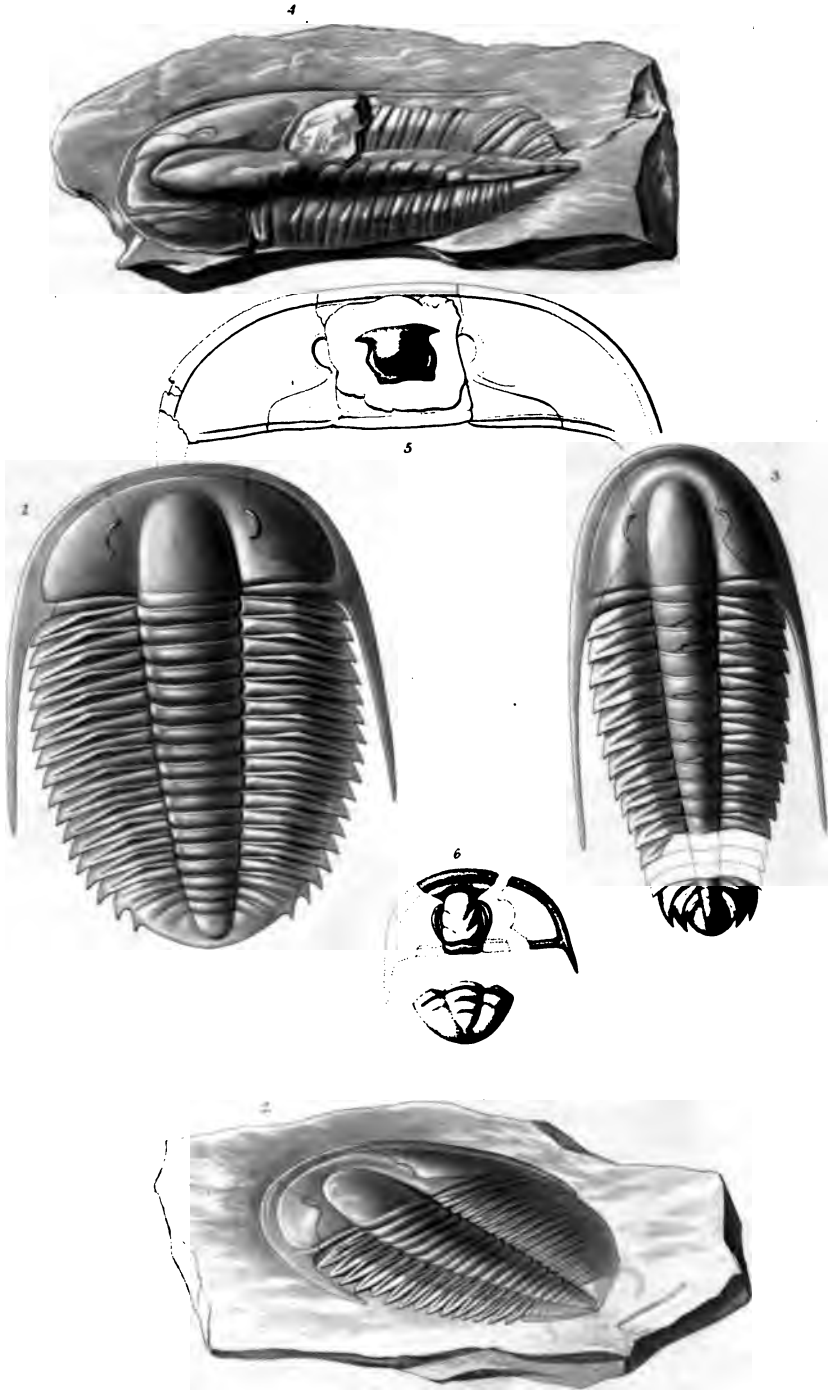
Explanation of Plate VI.

Fig. 1, 2. *Salteria primæva*, Wyv. Thomson; specimens, natural size, from the Caradoc schists of Penwhapple Glen, Ayrshire. (Mus. Wyv. Thomson.)

Fig. 2 *a*, 2 *b*, 2 *c*. The same magnified.

J. W. Salter.

November 1864.



1–5 ANGELINA SEDGWICKI, *Salter.* (*Tremadoc Slate*)

6 CONOCORYPHE INVITA, *Id.* (*Up. Lingula Flags*)

J.W. Salter del. et lith.

BRITISH FOSSILS.

DECADE XI. PLATE VII. FIGS. 1–5.

ANGELINA SEDGWICKI.

[Genus ANGELINA. SALTER. (Sub-kingdom Articulata, Class Crustacea. Order Trilobita. Family Conocephalidæ.*) Depressed, head smooth, and with long posterior spines; eyes small, sub-median, without ocular ridge: glabella lobeless. Body segments 14–15, with an angular fulcrum, facetted for rolling up. Tail of few (four or five) segments. Labrum emarginate.]

DIAGNOSIS. *A. ovata, segmentis trunci* 15, *axi quam pleuris paullo angustiori. Caudâ utrinque bispinosa.*

SYNONYMS. *A. Sedgwicki*, SALTER, Siluria, 2nd ed., 1859, p. 53, foss. 9, fig. 2. *A. subarmata*, ib., fig. 3 (specimens pressed laterally and lengthened). *A Sedgwicki*, Memoirs Geol. Surv., vol. iii. (ined.) pl. 7.

The new forms illustrated on our plate were part of the results of a survey by myself in 1853 of the "Lingula Flags" and overlying beds in the mountain region extending from Tremadoc to Ffestiniog, and thence to Arenig-fawr, west of Bala. They have since been collected by the hundred, and are really common fossils.

The affinities of the genus are equally balanced between *Olenus* and *Conocoryphe*. *Angelina* differs from *Olenus* by having the pleuræ grooved and facetted for rolling up, instead of flat and produced into points; nor do we know of any *Olenus* that is totally without glabella furrows. It is this latter character, with the occasionally spinose tail, which distinguishes it from *Conocoryphe;* but this is combined with some characters of habit, such as the long head spines, less marked cephalic furrows, both axal and marginal (indicating probably a thinner crust), and much less deflexed pleuræ, with the fulcrum nearer the axis. *Angelina*, too, wants the ocular ridges of *Conocoryphe*. From *Arionellus* the less number of body

* The *Conocephalidæ* (Salter) differ essentially from the *Calymenidæ* by the variable but larger number of body rings, and the course (posteriorly) of the facial suture. They seem to have had a thinner crust, and, as a character of habit, resemble the *Olenidæ* in the long head spines and often sub-spinous tail border.

rings separates it, and that genus has so broad and expanded a margin, which is without a furrow, and the facial suture so far outwards, that there evidently is but little affinity with *Angelina*. The genus is named in honour of the Swedish paleontologist, who is carefully illustrating the old rocks of Christiania. Two fasciculi of his quarto work are already published, and we wait anxiously for the remainder. His *Calymene? leiostraca*, Pal. Suecica, t. xix. fig. 3, may very possibly belong to this genus.

Description.—Usually three or four inches long (one specimen fully six inches), of a broad oval contour, the head blunt, and the tail only moderately pointed. The head occupies less than one-third of the length, and is semicircular, but rather truncated forwards; a narrow equal margin, not raised or thicker in front, runs all round, scarcely broader than the occipital border of the cheek, and continuous with it; an equal space separates this margin in front from the glabella, which is parabolic, much longer than broad, and quite destitute of any lobes. It is about equal in width to the cheeks (exclusive of their margin). The cheeks themselves are gently convex, smooth, and bear the small curved eye midway, but nearer the glabella than the marginal furrow. The facial suture is nearly vertical to them above, and then turns sharply outwards to cut the posterior margin at its outer third.

The labrum is seen on one or two specimens. It has a central raised portion, separated by rather a deep groove from a flat margin, which is broadly and abruptly truncate at the apex.*

Thorax of 15 segments; the axis narrower than the sides, gently convex, and tapering quite regularly backwards. The pleuræ are nearly direct, slightly produced and bent back at their ends, and grooved throughout. They are bent down a little from the angular fulcrum, which is placed at rather more than one-third in front (our figure shows it too far out at this point), and at much less than one half in the middle segments. The hindermost segments are scarcely at all produced or curved backwards; and all the segments are facetted for rolling. The pleural groove is deepest beneath the fulcral point, and as beyond this the facet bounds it in front, and the posterior edge of the segment is convex beyond the fulcrum, the groove becomes an elongated rhomboidal depression: a feature

* It is a little like that of *Lichas*, but is without the terminal notch and the "auricles" or lateral wings, and differs from that of *Olenus* by its broad margin. *Conocoryphe* has a labrum without so broad a margin, and not nearly so truncate.

not often seen in those genera in which the faculty of rolling up is lost or very limited.

The tail is more pointed than a semicircle, the axis not as broad as the sides, with two distinct rings, and a bluntish terminal portion not reaching the tip. The sides are marked by two lateral furrows which just reach the margin, opposite to the two short lateral spines. The upper furrows are duplicated. The *incurved under margin* * is very narrow, but convex.

The compressed and elongated specimens (figs. 3, 4) were formerly considered to be of a distinct species, not, however, on account of the form, which I was aware might be due in great part to pressure, but on account of the spinose border to the tail, a character I had not at the time seen in figs. 1 and 2. A noble series of specimens, distorted in every possible way, have been lately transmitted by Mr. D. Homfray, of Portmadoc, who has collected the fossils of that district with much success.

These specimens show 15 segments (our figured specimens only showed 14), and they prove clearly that the spinose border to the tail occurs in all well-preserved specimens, yet in some more distinctly than others. And the great difference in appearance between figs. 2 and 3 is entirely due to the different direction in which the fossils have been pressed in the stone. The pleural grooves in the one case are all but obliterated (fig. 3), in the other they are deepened (fig. 2), and the spinose border to the tail (in fig. 3) appears to be increased in length; in fig. 2 it is reduced. The somewhat greater space in front of the glabella, and the long head spines in fig. 3, are differences which may possibly (if they be found constant) be referable to sex.

Locality and Geological Position.—Upper Beds of the Tremadoc Slates, Garth Hill, east side of Traeth Bach, Tremadoc, N. Wales; also Portmadoc Quarries, and at the Ynys Tywyn, in similar beds. (Mus. Pract. Geol., and cabinets of Messrs. Homfray, F. Ash, and Mr. E. Roberts, surgeon, and many other collections.)

Genus—CONOCORYPHE.

It is not usual to include more than one genus in a plate; but accident having introduced a *Conocoryphe* upon the plate of

* We want a term for this incurved striated under margin, which is always more distinct in the tail than elsewhere. Being always or most generally parallel-sided in the tail, it might conveniently be termed the "*caudal fascia*;" in the pleuræ, the "*pleural fascia*," but the term is hardly necessary for any portion but the tail, where the relative width of the *fascia* is of specific importance.

Angelina, advantage is taken of it to present the English reader with the characters of a genus which is more common, or at least better known, in Sweden and Bohemia, than in England.

Conocoryphe belongs to the same primordial family as *Angelina*, and differs from it chiefly in the lobed glabella. M. Barrande gives the following characters.*

[Genus CONOCORYPHE. CORDA. (Sub-kingdom Articulata. Class Crustacea. Order Trilobita. Family Conocephalidæ.) "Glabella shortened, narrowed in front, with three or four pairs of oblique furrows. Axal furrows deep. Eyes (usually present) reticulate. Facial suture ending within the posterior angle. A rostral shield present. Labrum elongate truncate. Thorax segments 10-15, furrowed and facetted for rolling. Tail entire, of two to eight segments." Barr., p. 417.]

[Section *Conocoryphe* proper. Eyes large, approximate. Glabella large, well lobed; 14 body rings; tail small. Lingula flags only.]

The other sub-genera, *Solenopleura*, &c., will be illustrated in future decades.

CONOCORYPHE* INVITA.

DECADE XI. PLATE VII. FIG. 6.

DIAGNOSIS. *C. capite (adhuc solùm cognoto) lati-marginato, angulis brevispinosis; glabellâ urceolatâ, utrinque bisulcatâ; oculis longis, ad glabellam appressis; caudâ angustâ, axi conico 4-annulato.*

SYNONYM. *Conocephalus invitus*, SALTER, in Siluria, 2nd ed., 1859, p. 47, foss. 7, fig. 1. Id. Mem. Geol. Surv., ined. pl. 4, figs, 5, 6, 7; pl. 7, fig. 6.

Description.—Of the head we have only fragments, but they show that the facial sutures converge greatly from the margin to the eye, which is very long, reaching two-thirds the whole length of the glabella, from the middle of the large basal lobe to above the upper lobe. The glabella furrows nearly unite in the centre and both pairs are very oblique, the basal pair almost meeting the deep arched neck furrow.

This species resembles so nearly *E. Emmrichii*, Barr., that were it not for the glabella having only two pairs of furrows, the frag-

* I think, much as we wish to preserve to M. Barrande all the honour of his careful nomenclature, that we cannot safely use the term *Conocephalus* or *Conocephalites* of Zenker, as the term has been employed in no less than three different genera of plants and animals. It is better to adopt Corda's term, the more so, as it is really likely that the subdivision of the genus proposed by him will be hereafter sanctioned.

ments might readily be mistaken for that species. The glabella, however, is longer, of an urceolate shape, and with the furrows reaching much further into it. The eyes are not quite so long, as they do not reach to the base of the lower lobes, and they are set quite close to the glabella, which is not the case in *E. Emmrichii.*

The tail is longer and narrower; the axis conical, with the terminal segment developed. Our species is altogether an excellent British representative of a genus common in Bohemia and Sweden.

Locality and Geological Position.—UPPER LINGULA FLAGS. Penmorfa Church and Carreg Wen, Tremadoc, N. Wales. Ogof ddu, near Criccieth. (Mus. P. Geol.)

It may be as well to mention here that 10 species of *Conocoryphe* are already known in Britain. Nine are described in the forthcoming Memoir of Professor Ramsay on the Geology of North Wales; and a fine species, with highly developed ornament, is found in the Lower Lingula Flags of St. David's. As the genus must be illustrated hereafter, I only give the names and references.

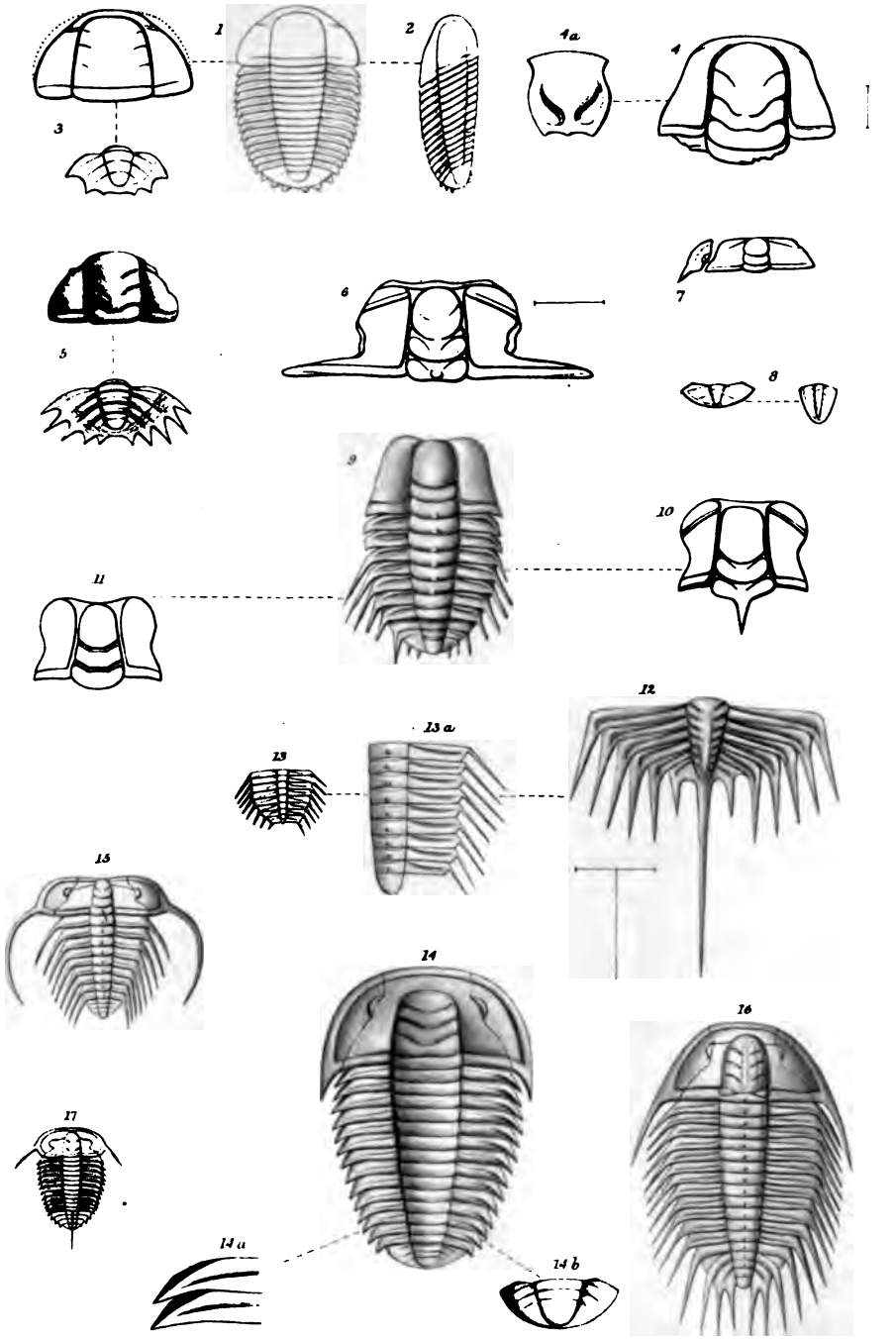
C. invita, Salter, Mem. Geol. Surv., vol. iii., ined., pl. 4, figs. 5, 6, 7; pl. 7, fig. 6, above described.
C. abdita, id. pl. 5, fig. 13, Upper Lingula Flag, Ogof ddu, near Criccieth.
C. sp. id. pl. 5, fig. 14 (fig. 15 tail ?), same locality.
C. sp. id. pl. 5, fig. 16, same locality.
C.? simplex, id. pl. 5, fig. 17, Upper Lingula Flag, Penmorfa Church.
C. vexata, id. pl. 8, fig. 7, Lower ? Tremadoc Slate, Penmorfa village.
C. depressa, id. pl. 6, fig. 1, 2, 3, Lower Tremadoc, near Penmorfa Church, and Wern, Portmadoc.
C.? verisimilis, id. pl. 6, fig. 13, Lower ? Tremadoc, above Penmorfa village.
C.? olenoides, id. pl. 8, fig. 6, Upper Tremadoc, Garth, Portmadoc.
C. variolaris, id. Quart. Geol. Journ., vol. xx., pl. xiii., figs. 6, 7, Lower Lingula Flags, St. David's, Pembrokeshire.

EXPLANATION OF PLATE VII.

Figs. 1–4. *Angelina Sedgwicki*, Salter, in various states of compression, according to the position in the slaty beds. (Mus. Pract. Geol.)
Fig. 5. Labrum of ditto in Mr. Homfray's cabinet. Upper Tremadoc, Garth Hill, opposite Portmadoc.
Fig. 6. *Conocoryphe invita*, Salter. Upper Lingula Flag, Penmorfa Church, Tremadoc, N. Wales.

J. W. SALTER.

November 1864.



Figs. 1 3 OLENUS SCARABÆOIDES. *Wahl.*
4 —— SP.
5 —— SERRATUS. *Salter.*
6 BISULCATUS. *Phillips.*

Figs. 7, 8 OLENUS FLAGELLIFER. *Angelin?*
9, 11 HUMILIS. *Phillips.*
12, 13 PECTEN. *Salter.*
14 —— CATARACTES. *id*

Figs. 15, 17 *are Swedish species for comparison.*

J.W. Salter direx.ᵗ J.W. Lowry fc.

BRITISH FOSSILS.

DECADE XI. PLATE VIII. FIG. 14.

OLENUS CATARACTES.

[Genus OLENUS. DALMAN, in part. (Sub-kingdom Articulata. Class Crustacea. Order Trilobita. Family Olenidæ.) Glabella oblong, or usually narrowed anteriorly, lobed; eye smooth, with a narrow prominent ocular ridge (*Costula facialis*, Angelin) connecting it with the upper part of the glabella; facial suture marginal in front, and cutting the posterior margin behind; cheeks spinous, no rostral shield; hypostome? labrum oblong, narrowed at base; pleuræ 7–15, (14 typically), pointed and curved; tail with articulated axis and sides.]

[British sub-genera. *Olenus*, DALMAN. Body rings 11-15, head semicircular, spines moderate, tail entire.—*Sphærophthalmus*, ANGELIN (including *Eurycare*, id.) Body rings 7–15; head transverse, with remote eyes and widely curved long spines.—*Parabolina*, SALTER. Body rings 12; head semi-lunar; eyes approximate; spines diverging; tail spinose.—*Peltura*, ANGELIN (not Milne-Edw.). Body rings 12; head narrow, with approximate eyes, and no spines; tail spinose.]

DIAGNOSIS. *O. ovatus 1½ uncialis et ultra, capite magno semilunari, spinis brevissimis. Glabella sulcis tribus fere perfectis. Oculi antici. Thoracis axis latus, pleuræ vix recurvæ brevispinosæ, fulcro remoto. Cauda minuta, transversa, semicircularis, axi latissimo.*

Several species of the well-known *Olenus* of Dalman are now added to the British list. The originally described British form is *Olenus micrurus*, in our Decade II., plate 9 (1849), also "Siluria," 2nd ed., p. 45, foss. 4, fig. 2. That is not, however, by any means a common fossil, and it is necessary now to distinguish from it the present species, which appears to be the ordinary form in the lower black shales of North Wales.

Description.—Nearly an inch and a half long, ovate, blunt at both ends, the head wide, nearly one inch broad, the body much narrower, tapering regularly to the tail. The head is sub-truncate, the glabella moderate in size, parabolic, not so broad as the cheeks, reaching forward nearly to the narrow front margin, and about the width of that margin distant from it, furnished with three pairs of furrows, of which the lower two are complete across. The eye is nearly as far forward as the front of the glabella, and somewhat

remote from it. The hinder angles of the head with the spines abrupt, short, scarcely reaching the fourth segment, directed backward, not outward as usual in the sub-genus.

Body rings 15 (our artist has only represented 14 rings), their axis convex, nearly as broad in all the rings as the pleuræ, which decrease regularly, not abruptly, in length from before backwards; they are obliquely pointed, with short spines directed outwards, but very little backward. The fulcrum of the pleuræ is placed beyond the half, even in the hinder rings.

Tail short, semi-oval, with a very wide axis, of three rings, and the sides with two furrows.

O. micrurus is easily distinguished from *O. cataractes* by the oblique lower glabella furrows, the shape of the small smooth subtruncate tail, and by the abrupt narrowing of the hinder body rings, which also have the fulcrum placed nearer than half way out from the axis. The tail is even more easily distinguishable, the width of the axis being greater than that of the sides, and having three rings, including the terminal portion; there are two lateral furrows, not one only. *O. cataractes* has 15 body rings. *O. micrurus* 14.

The head is much like that of *O. micrurus*, but the lower glabella furrows run quite across. Compared with the Swedish *O. truncatus*, the greater breadth of the cheeks, and the longer, more parabolic form of the glabella, will distinguish it. I do not compare the caudal portions, for Angelin's figure looks as if there were some mistake in this part. Possibly two of the caudal rings as figured by him belong to the body, which otherwise would have but 13 rings—a difference hardly to be expected in such closely allied forms.

O. truncatus is, I think, from higher beds, at Andrarum in Scania, than our Lower Lingula flags, but this is a point not yet sufficiently investigated.

Localities and Geological Position.—LOWER LINGULA FLAGS, Maentwrog Waterfall, Merionethshire, in black shaly strata full of *Agnostus princeps*; also at Treflys, E. of Criccieth, Carmarthenshire N. Wales, where I found the figured specimen in 1859. Specimens probably identical are found at the Dolgelly gold mines.

OLENUS (SPHÆROPHTHALMUS) FLAGELLIFER.?

PLATE VIII. FIGS. 7, 8.

SYNONYMS. *Sphæroph. flagellifer*, ANGELIN, Pal. Suecica, pl. 26, fig. 7.? SALTER, Mem. Geol. Surv., vol. iii. ined. pl. 5, figs. 8, 9.

The only difference I can see between the Tremadoc specimens and the figure by Angelin is, that the glabella furrows in ours run quite across, while Angelin gives them as only lateral. But as this character of the complete transverse furrows seems to belong to the whole of the *Sphærophthalmi*, perhaps the Swedish artist has not sufficiently represented it. The other characters of the sub-genus (for it can, I think, only be so regarded) are the short and wide transverse head, the cylindric glabella reaching the front margin, and the very large curved head spines.

Again, *Eurycare*, Angelin, which I regard as only *Sphærophthalmus*, has a somewhat broader front, and wider and more parabolic glabella, thus leading from *Sphærophthalmus* to the true *Oleni*, of which *O. gibbosus* may be taken as the type. The characters seem to me not to be absolute in any of these sub-genera, and hence they may all, I think (and Barrande seems to be of the same opinion), be conveniently retained in *Olenus*.

Description.—Our specimens are so imperfect, that I do not pretend to give a true diagnosis, nor do I feel quite sure I have identified it rightly.

The head is very transverse and has parallel edges. The glabella is nearly square, and has only two pairs of furrows. The lower reach far across, and appear quite complete in some specimens; the upper, not represented in our scanty figure, only lateral and short. The ocular ridge is distinct and oblique. The margin very narrow. The neck segment also narrow. The free cheeks rotund, the eye large and prominent; the spine seeming to start from the outer edge above the angle. The thorax rings are strongly furrowed, their axis moderately broad.

The tail is entire, sub-triangular, with a conical axis, and furrowed sides. Our specimen shows no trace of a spine such as Angelin figures and describes.

I think the species is a distinct one, but in the absence of more complete materials, do not think it worth while to separate it from its near ally. Our figure is necessarily imperfect, but might have

shown more clearly the upper pair of glabella furrows and the outwardly placed head spines; the eye is also too small.

Locality and Geological Position.—Upper Lingula Flags, Carreg Wen, Borth, Portmadoc. (Mus. Pract. Geology.)

OLENUS (PARABOLINA) SERRATUS.

Plate VIII. Fig. 5.

Diagnosis. *O. modicus, 1½-uncialis, convexus. Glabella oblonga æquilata, haud parabolica, anticè subtruncata, sulcis utrinque binis longis fere medium glabellæ attingentibus, paullo obliquis. Sulcus cervicalis vix continuus. Oculi valde antici. Genæ angustæ. Cauda (hic haud dubiè referta) semicircularis axi prominulo 4 costato, obtuso; lateribus utrinque 5-dentatis, dentibus patulis limbo brevioribus; hôc 4-sulcato, sulcis omnibus distinctè interlineatis.*

Synonyms. *Olenus (Parabol.) serratus*, Salter, Mem. Geol. Surv., vol. iii. ined. pl. 5, figs. 6, 7.

Description.—Glabella quite as wide in front as behind, with a broad neck segment, equal in breadth to the basal lobe. The second or middle lobe somewhat narrower. Fixed cheeks broad, sub-trigonal, equal to more than half the width of the glabella, the eye placed very far forwards, opposite the forehead lobe. Free cheeks not known, probably narrow.

Tail, most likely of the same species, semicircular, serrate, with short, somewhat radiating spines. Axis thick, of four prominent rings and a blunt terminal piece; sides four-ribbed, the ribs duplicate, and produced on the margin into strong spines of less length than the limb, five on each side, the fifth pair of spines being set rather wide apart beneath the axis.

Affinities.—I much wish I could identify this with the common *O. spinulosus*, Wahl., for the head is very like. But the caudal shield is decidedly different, and as it in all probability belongs to the same species as the head, I feel bound to keep the two distinct. The glabella, moreover, differs, as above described, from that of the true *O. spinulosus*, which tapers a little forward. In that species the tail spines also are greatly lengthened.

History.—The section *Parabolina*, regarded as a genus by Angelin, was proposed by me in 1849 to distinguish the species of *Olenus* which have 12 body rings and a laciniate tail. *O. scarabæoides* might perhaps belong to this sub-genus as so defined, but

it has 13 body rings, and clearly belongs to a different natural group, in which the cheeks are much contracted, and the glabella enlarged; in the majority of *Oleni* the reverse is the case.

I believe Angelin has good reasons for supposing there are several distinct genera included under *Olenus*, but I do not quite see the way to their definition yet. The term *Peltura* can only stand by courtesy, for it was founded on a species of *Lichas*, as may be seen by reference to Capt. Fletcher's description of the British Upper Silurian species of that genus.*

Locality and Geological Position.—UPPER LINGULA FLAGS, Carreg Wen, Borth, Portmadoc.

OLENUS SCARABÆOIDES.

PLATE VIII. FIGS. 1–3.

SYNONYMS. *Vermiculites vagipennis*, BROMELL, in Act. Lit. Upsal., 1729, pp. 525, 528, cum icone. *Entomostracites scarabæoides*, WAHLENB., Nova Act. Soc. Upsal., vol. viii. t. 1, f. 2. *Olenus scarab.*, DALMAN, Palæadæ, p. 257. *Olenus scarab.*, HISINGER, Lethæa Suecica, t. 4, f. 4. *Paradox scarab.*, BRONGNIART, Crustaces, foss. p. 34, t. 3, f. 5. *Peltura scarab.*, MILNE-EDW., Crustaces, vol. iii. p. 344 (1840). *Peltura scarab.*, ANGELIN, Palæont. Suecica, pl. 25, f. 8 (mala), 1855. [*Olenus spinulosus?* PHILL., Mem. Geol. Surv., vol. ii. pt. 1, pp. 55, 239.] *O. scarab.*, SALTER, Siluria, 2nd ed., Appendix, p. 540. *O. scarab.*, Id., Mem. Geol. Surv., vol. iii. ined. pl. 5, figs. 2–5.

In size, as well as form, these pressed and distorted Trilobites agree pretty well with Christiania specimens presented by Dr. Th. Kjerulf to the Mus. Pract. Geology. But ours show only one ring to the axis of the tail besides the terminal lobe. Wahlenberg's fossil has two rings to the axis. The marginal spines are only clearly seen in one British example; they do not differ from the Swedish species except in being shorter (see fig. 3). The glabella in our specimens is broader, and the lobes less distinct. It is manifest, therefore, that there are sufficient differences to render it probable that better specimens will require us to distinguish it. I shall at present call it—

Var. OBESUS.

The following characters appear to me to be constant, and I find them both in N. Welsh and Malvern specimens.

* Quart. Geol. Journ., vol. vi. p. 235.

General form broad oval, seldom reaching in length above an inch; of this the head occupies fully one-third. It is semi-oval, without the fixed cheeks (fig. 1), but with them (and perfect heads in Mr. Edgell's collection show them well) it becomes transverse-oblong. The broad parabolic flattened glabella is more than equal to the width of the cheeks, and has usually straight sides, sometimes in Malvern specimens a little contracted in the middle (fig. 4). Lobes very slightly marked (our fig. 4 has them too strong). The neck segment enlarged at the sides, and quite distinct across. The three pairs of furrows obscure. A very narrow margin in front of the glabella. The fixed cheeks narrow triangular, the eye very far forward, and connected with the front of the glabella by a low ocular ridge. The neck-furrow on the cheeks very near the hinder margin. Free cheek semicircular, very convex on its outer edge, and with a strong but narrow margin, and no spine, the base losely contracted.

Labrum (fig. 4 *a*), in a Malvern specimen lent by the Rev. W. Symonds, squarish, urceolate, with the base not expanded, the sides convex, the apex broadly truncate; the lateral furrows oblique, broad, not deep.

Body rings 14 (in a specimen lent by Mr. Ash, fig. 1). But this number is somewhat doubtful, as I find my notes say it has only 12 distinct ones. The Swedish fossil has 13, according to Angelin's figure, but his description gives 12, probably the true number. Ours do not show a central tubercle.

Tail semicircular, with broad blunt axis, showing one distinct ring, and a larger terminal portion. The sides as broad as the axis, and with three obscure furrows, the margin distinctly tridentate on each side, with short spines, not much projecting beyond the border, which is not at all marginate.

I believe we may safely identify with this the small species found at Malvern (pl. 8, fig. 4), and described by Phillips under the name of *O. spinulosus*. We have copied his figure, Mem. Geol. Surv., vol. ii. pl. 1, p. 55. It is certainly not Wahlenberg's species of that name. The furrows of the glabella are far too plainly marked in our figure, but the slight contraction visible on the sides of the glabella is correct for Malvern specimens.

Taking all the evidence together, I am inclined to think the British fossil distinct from the Swedish; and I am principally indebted to Mr. Edgell for the specimens which lead to this conclusion. I shall retain the name under which our fossil is usually

known till we have more complete evidence that the var. *obesus* is distinct as a species from the well-known Swedish type.

Locality and Geological Position.—UPPER LINGULA FLAGS, Carreg Wen, near Borth, and Penmorfa Church, both near Tremadoc, N. Wales. Abundant at Whiteleaved Oak, Malvern, in the UPPER LINGULA FLAGS (Black Shales) of that locality.

OLENUS (SPHÆROPH.) HUMILIS.

PLATE VIII. FIGS. 9–11.

DIAGNOSIS. *O.* (*Sph.*) *minutus, capite angusto antice emarginato, pleuris 7, posticis solum spinosis, caudâ sexcuspidatâ. Glabella convexa angusta parabolica, sulco basali completo, reliquis obsoletis, cervice spinoso. Genæ convexissimæ, oculis omnino posticis, magnis. Thorax 7-costatus, pleuris duobus anticis muticis, reliquis spinosis. Cauda brevis semicircularis, 6-spinosa, spinis externis majoribus.*

SYNONYMS. *Olenus humilis*, PHILL., Mem. Geol. Surv., vol. ii. pt. 1, pl. 55. SALTER, Mem. Geol. Surv., vol. iii. ined. pl. 5, fig. 12.

This minute species is well characterized by its very narrow instead of wide cheeks. Yet in other respects it is a perfect *Sphærophthalmus*, and such a copy in miniature of the *Olenoid* type, with nearly all the characters exaggerated or reduced, as to show us that great variation is to be found within its limits, and to induce us to regard the various groups into which *Olenus* has been divided as sub-genera rather than distinct generic types.

Description.—A minute form, not above a quarter of an inch in length, and of an ovate shape; the head broadest, as usual in this sub-genus, but rather squarish-oblong, with an emarginate front, the very convex cheeks projecting on either side so much forward as to bring their greatest convexity in advance of the narrow parabolic glabella! The facial suture follows this convexity in a sigmoid line, cutting the front margin at a short distance outside the axal furrow, then curving outwards widely, and then again at the lower third much contracted inwards to the place of the eye, which is near the base of the cheek. The eye-lobe which covers it is elevated and easily broken away, being divided by a deep furrow from the fixed cheek.

The eyes are large and round, and placed quite at the base of the free cheeks, which are true semicircles, strongly margined, and completely contracted to a point behind, showing (so far as I can see)

no trace of the curved spine characteristic of this sub-genus. Our figured specimens had not the free cheeks in any case. Mr. Edgell's specimens show them well.

Body short, of seven rings only,* with a broad axis, showing in the five front rings the central tubercle. The pleuræ are short, strongly grooved; the two front ones without recurved spines, the rest spinous; the spines bent strongly back and about as long as the pleuræ.

The tail is nearly a semicircle, and furnished with a strong conical three-ribbed axis, which reaches the end. The sides two-ribbed, with three spines on each side, the forward one longest, the other two short, and leaving a rather broad smooth space at the extremity of the tail beneath the axis.

Locality and Geological Position.—Only known in the BLACK SHALES of Malvern, Fowlet's Farm, and Whiteleaved Oak Farm, &c., and very abundant there, with other species of the genus next described.

OLENUS BISULCATUS.

PLATE VIII. FIG. 6.

DIAGNOSIS. *O.* (*Sph.*) *modicus, capite transverso, glabellâ bisulcatâ, genis latissimis. Thorax pleuris latis, profunde sulcatis, spinis validis rectis.*

SYNONYM. *O. bisulcatus*, PHILL., Mem. Geol. Surv., vol. ii. pt. 1, p. 55, fig. 1.

The head of this species is remarkably wide, and thus differs at a glance from *O. humilis*, with which it occurs. The body rings have lately been detected in the cabinet of my friend, Mr. Edgell, and I am thus enabled to improve the description. The species is stouter in all its parts than is usual in the sub-genus.

The species is a small one, not more than eight lines in length, and the width from tip to tip of the stout thorax spines seven lines. The head is very transverse, three times as wide as long, even excluding the free cheeks, which we do not perfectly know, but believe to have extended somewhat further out, and to have been armed with a stout curved spine starting one third or thereabouts above the genal angle. The front is straight, or only slightly emarginate, and the

* The species is abnormal for the genus, abnormal even for the sub-group to which it belongs. It contradicts most of the technical characters of *Olenus*, and yet evidently belongs to it.

margin narrow, the long sub-cylindrical glabella touching it. The axal furrows are deep; the glabella narrower forwards and rounded in front, with a strong neck-lobe, not spinous but with a central tubercle, a pair of complete basal grooves cutting off the lower third of the glabella, and an incomplete upper pair.

The fixed cheeks consist of an oblong convex plate in front of the eye, which is placed far back, opposite the basal furrow, and about the width of the glabella apart from it. The ocular ridge is very oblique, and only reaches the front edge of the broad eye lobe. The facial suture is sinuous, but nearly vertical to the eye, and beneath it turns abruptly outwards in a line all but parallel to the neck margin, and reaches it at a distance from the glabella equal to twice the width of that organ. The neck furrow is narrow, but distinct all along.

[The cheek, in a separate specimen of Mr. Edgell's probably belonging to this, is a quadrant of a circle, with a round prominent eye, and a narrow margin on the outer edge. The spine starts considerably above the angle, and on the level of the eye, and appears to be short and not much curved.]

Thorax of — ? rings. We have only six preserved; they are broad, straight, equal in width to the axis, excluding the strong patent spine, which bends very little backward, and is about as long as the pleuræ themselves. The pleural groove is deep and broad, and reaches the base of the spine. The axis is convex, and has a spinous tubercle on each segment.

Locality and Geological Position.—UPPER LINGULA FLAGS, Whiteleaved Oak, Malvern. (Mus. Pract. Geol.)

OLENUS (SPHÆR.) PECTEN.

PLATE VIII. FIGS. 12, 13.

DIAGNOSIS. *O. parvulus monstrosus, capite contracto longispinoso, thorace multispinoso, caudâ mirâ pectinata et in spinam longissimam centralem producta. Caput ad frontem emarginatum, glabellâ brevi, genâ angustâ spinam medianam curvam gerente. Oculis omninc antrorsis. Thorax pleuris rectissimis, spinis aciculatis. Cauda spinis utrinque sex parallelis, et medianâ longissima.*

Oblong, the head contracted in width, emarginate in front, with narrow glabella, and furnished with convex projecting cheeks,

bearing very forward eyes. They are placed on the most prominent part of the cheeks, opposite the front of the glabella, and about midway from it. The fixed cheek is wider than the glabella, but the free cheek is not so wide, and much resembles that of *O. humilis*. And the facial suture, as in that species, is nearly vertical below the eye as well as above it.

The head-spine does not in this species start from nearly the base, but quite up in the middle of the free cheek. It is only slightly curved; but arising from so unusual a position, it has a most odd appearance. It reaches to the seventh thorax ring.

The thorax-rings are much wider than the head, and remarkably straight across. The axis is not above one-third the width of the straight pleuræ, which are even a little curved upward, and grooved throughout; they bear a straight spine, directed obliquely backwards, and longer in the hinder segments. We only know seven rings; there must have been several more.

Mr. Turner, schoolmaster at Pauntley, Gloucestershire, was the discoverer of this curious species, and sent it to the Rev. W. Symonds. It has since occurred in greater plenty. Mr. Edgell has perfect heads and several caudal portions. The Rev. T. B. Brodie has an excellent specimen.

Locality.—With the preceding.

The group of species last described rather fully illustrate the curious sub-genus *Sphærophthalmus*, and show how wide in these ancient genera the limits of variation are in a single group. As we ascend in the geological scale, the law of variation becomes more restricted, and characters which are of family value in the more advanced groups scarcely afford generic distinctions in some of the more ancient and less highly organized ones.

The *Olenidæ* and the *Asaphidæ* have both of them wide limits, and it may be possible bye and bye to subdivide them.

Locality and Geol. Position.—Upper Lingula Flags, White-leaved Oak, Malvern.

Figs. 15, 16, 17.

I have figured the Swedish *O. spinulosus* (fig. 16,) to give the British student an idea of what form to look for when searching for fragments of *O. serratus*. Fig. 15 illustrates perfectly the sub-genus *Sphærophthalmus*, while it is also a common Upper Lingula Flag fossil for Britain (see Mem. Geol. Surv., vol. iii. ined., pl. 4). Fig. 17 is Angelin's sub-genus *Leptoplastus*, which I regard as a form of *Sphærophthalmus*, and may illustrate in part our *O. pecten* and *O. flagellifer*. *Olenus* proper and *Peltura* are sufficiently represented by our own species.

Other British Species.

O. micrurus, Salter, Decade II., pl. 10, (section *Olenus*).

O. *alatus*, Bæck, our pl. 8, fig. 15, and Salter in Mem. Geol. Surv., vol. iii. ined., pl 4, fig. 3 (section *Sphærophthalmus*.)

Explanation of Plate VIII.

Figs. 1–4. *Olenus* (*Peltura*) *scarabæoides*, Wahl.? (possibly a new species), var. *obesus*, Salter. Fig. 1. Natural size, uncompressed (Mr. Ash's cabinet). Fig. 2 compressed (Mus. Pract. Geology.) Fig. 3, slightly enlarged ; specimens are, however, occasionally found nearly of these dimensions.

Fig. 4. Malvern specimen, the same figured by Phillips in Mem. Geol. Surv., vol. ii., pt. 1, pl. 55. The glabella furrows are far too strongly marked.

Fig. 4 *a*. Labrum, from Malvern. Upper Lingula Flag (Black Shales).

Fig. 5. *Olenus* (*Parabolina*) *serratus*, n. sp., Carreg Wen, Portmadoc.

Fig. 6. *Olenus* (*Sphærophthalmus*) *bisulcatus*, Phill. His original specimen from Malvern, in Upper Lingula Flag.

Figs. 7, 8. *Olenus* (*Sphær.*) *flagellifer*, Angelin.? Carreg Wen, Portmadoc, Upper Lingula flag.

Fig. 9. *Olenus* (*Sphær.*) *humilis*, Phill., Malvern. Dr. Grindrod's cabinet (magnified).

Figs. 10, 11. Heads of the same (the free cheeks lost). Same locality. (Survey collection.) Abundant in the Black Shales.

Fig. 12. *Olenus* (*Sphær.*) *pecten.*, n. sp. Same locality. (Rev. W. Symonds' cabinet.)

Fig. 13. Thorax of do., natural size and magnified. Same locality and cabinet.

Fig. 14. *Olenus cataractes*, n. sp., Lower Lingula Flags, Treflys, near Criccieth (Mus. Pract. Geol.) 14 *b*. Tail enlarged. 14 *a*. Pleuræ.

We have figured three Swedish fossils to illustrate sub-genera imperfectly represented by British specimens. All are from the primordial zone.

Fig. 15. *O.* (*Sphær.*) *alatus*, Bæck, copied from Angelin.

Fig. 16. *O.* (*Parabolina*) *spinulosa*, Wahl. do.

Fig. 17. *O.* (*Leptoplastus*) or *Sphærophthalmus raphidophorus*, Angelin, copied from his Palæont. Suecica, pl. xxvi., fig. 2.

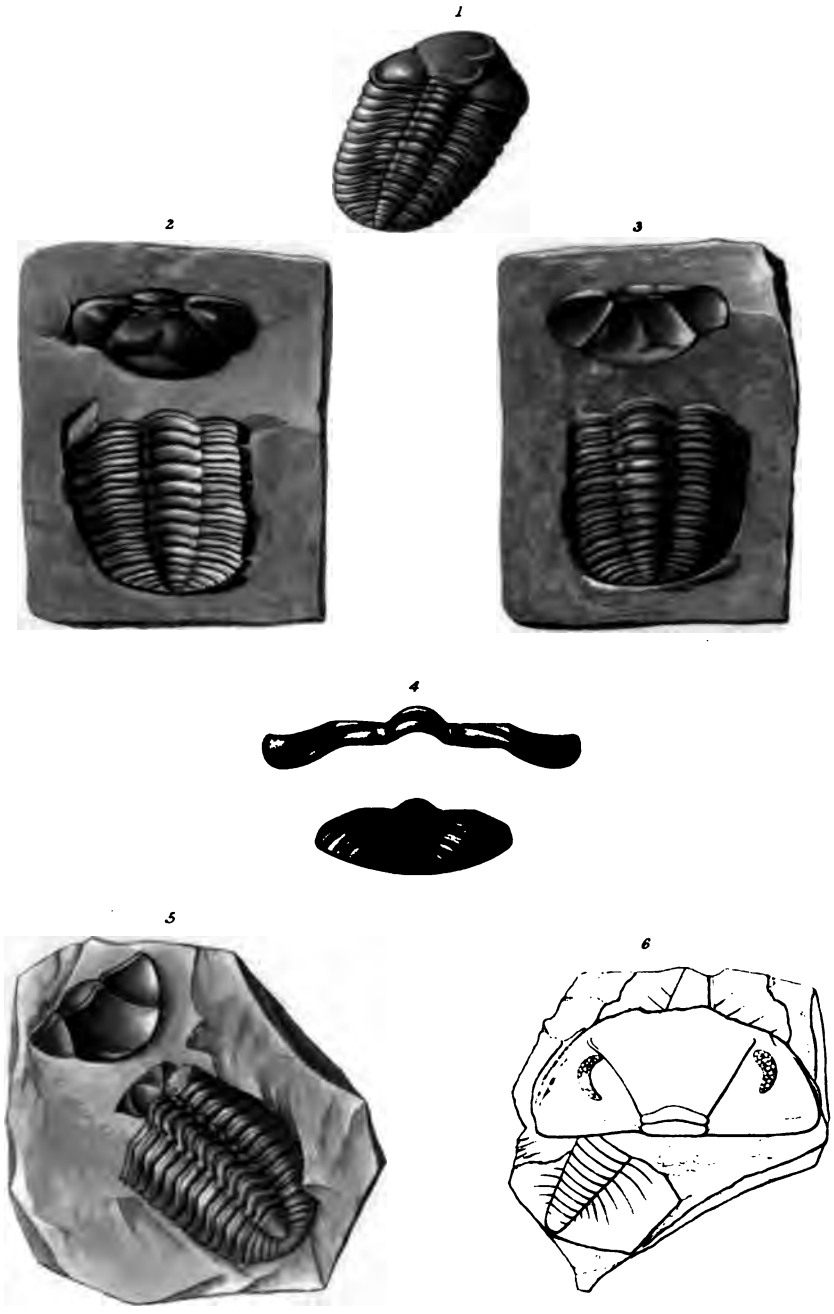
J. W. Salter.

November 1864.

PHACOPS

(SUBGENUS TRIMEROCEPHALUS)

(Devonian.)



Figs. 1–5 PHACOPS (TRIMEROC) LÆVIS—*Münst.*

6 CRYPTOPHTHALMUS *Emmr.* (from Sandberger.)

BRITISH FOSSILS.

DECADE XI. PLATE IX. FIGS. 1–5.

PHACOPS (TRIMEROCEPHALUS) LÆVIS.

[Genus PHACOPS. EMMRICH. (Sub-kingdom Articulata. Class Crustacea. Order Trilobita. Family Phacopidæ.) Eyes largely facetted; facial suture ending on the outer margin; thorax 11-jointed.]

[Sub-genus *Trimerocephalus*. Form compact. Glabella inflated and expanded or wards, the lobes, except the basal ones, obscure. Eyes very small, of few large lenses (often lost by abrasion) or absent. Head angles not spinous. Facial sutures soldered. Thorax with pleuræ all rounded. Tail small, of few segments, with even border, and not at all produced.]

DIAGNOSIS. *P. (Trim.) cæcus, latè ovatus lævis, glabellâ latissimâ, brevi, genas subsphericas trigonas superintendente; lobis basalibus minutis distinctis. Thoracis axis angustus, fulcro pleurarum axin approximato, sulcoque brevi. Cauda latissima brevis, axi longo, 5-annulato, lateribus 4-sulcosis, margini nullo.*

SYNONYMS. *Trinucleus lævis*, MÜNST. Beitr. Heft 5, t. x. fig. 6 (1842). *Calymene lævis*, PHILL., Pal. Foss., pl. 55, fig. 250 (1841), (not *Cal. lævis*, MÜNST., l. c. t. v. fig. 4). *Asaphus* or *Trinucleus*, SOWERBY, Geol. Trans., 2nd Ser., vol. v. pl. 57, fig. 30 (1840). *Trimerocephalus lævis*, McCOY, Ann. Nat. Hist. vol. iv. p. 404, woodcut (1849). Ibid, Synopsis Woodw. Mus., p. 178 (1851). SALTER. Palæont. Society, Monogr. (1864), p. 16, pl. 1, figs. 5, 6, 7.

It would perhaps be better if a new name were bestowed upon this species. It is clearly enough the *Trinucleus lævis* of Münster, and that fossil belongs to *Phacops*. But the *Phacops* (*Calymene*) *lævis* of Münster is quite another thing, and typical of another section of the genus; and if the latter were a good species, and not a mere synonym of *P. granulatus*, as I believe it to be, it would be imperative to change the name, and I would then propose the term *P. trinucleus* for this species. At present it had better stand as *P. lævis*.

There is less difficulty about the name of the sub-genus. That bestowed by McCoy is convenient enough, the group being a really good one, distinguished by the soldered head sutures and especially the absence of eyes.* No trace can be seen of these organs in the present species.

Description.—Rarely exceeding an inch and a quarter long, of a broad oblong-oval shape, the head being nearly one-third the whole length, convex, and divided deeply into three tumid lobes, of which the lateral ones or cheeks are not above half the width of the glabella. This is "sub-rhomboidal," or spherical-triangular, convex, smooth, twice as broad in front as behind, where a very narrow pair of basal lobes separates it from the neck-ridge; the upper furrows are quite obsolete. The cheeks are trigonal, the shortest side being the outer or marginal side, very evenly convex, and with no trace of an eye. They are bordered by a very distinct and rather broad smooth margin, which is continuous at the rounded posterior angles of the head, and lost in front, where it abuts against the glabella.

Thorax of 11 segments, with convex narrow axis and rounded pleuræ; the segments of the axis tuberculate at the sides; the pleuræ not much bent back, rounded at the end, the groove narrow and short, the fulcrum placed at less than half way out; the facet rather large.

The tail is short and broad; its length not half its breadth, and both forward and hinder edges being curved, so as to give a lenticular outline. The axis is suddenly narrower than that of the thorax, conical and gently convex, attaining very nearly the border of the tail, blunt at the tip and marked with four or five transverse furrows. The sides have four radiating bent furrows, which are faintly interlined and nearly reach the edge; there is no distinct border to the tail.

The species was first figured in England (from the only English locality I know of, viz., the Knowl Hill, near Newton Bushell,) in the plates executed by Sowerby for the Devonshire Memoir of Professor Sedgwick and Sir R. I. Murchison.† That figure is from

* *Trimerocephalus* has been lately made to include all the species with lobeless or very faintly lobed glabella and soldered sutures and superficial minute eyes, *e.g.*, *Phacops Volborthi*, Barrande, and *P. cryptophthalmus*, Emmrich, which last is figured on our plate for comparison. But it will probably be hereafter restricted to the present species and kindred forms, since the most careful scrutiny fails to detect the least trace of eye or facial suture.

† Trans. Geol. Soc., 2nd series, vol. v., 1840.

an uncompressed specimen, but they are mostly distorted, and, as noticed by Mr. Pengelly, the head is generally disjointed from the body and inverted, as if the animal had habitually kept it bent under, and been preserved in the slate in that position. In that posture, and exposed to the accidents of slaty cleavage, it is often difficult to distinguish the parts correctly; and the juxtaposition of two specimens, or the extra elongation along the line of cleavage, have often given rise to a specimen with apparently more than the proper number of body rings, and to all sorts of abnormal proportions of the various parts.

Locality and Geological Position.—UPPER DEVONIAN. Knowl Hill, Newton Bushell. It is quoted by Phillips from S. Devon, at Mudstone and Durlstone Bay. I think there is much doubt of these *Lower Devonian* localities, but less doubt about Brushford, N. Devon, in the Marwood or Pilton group.

EXPLANATION OF PLATE IX.

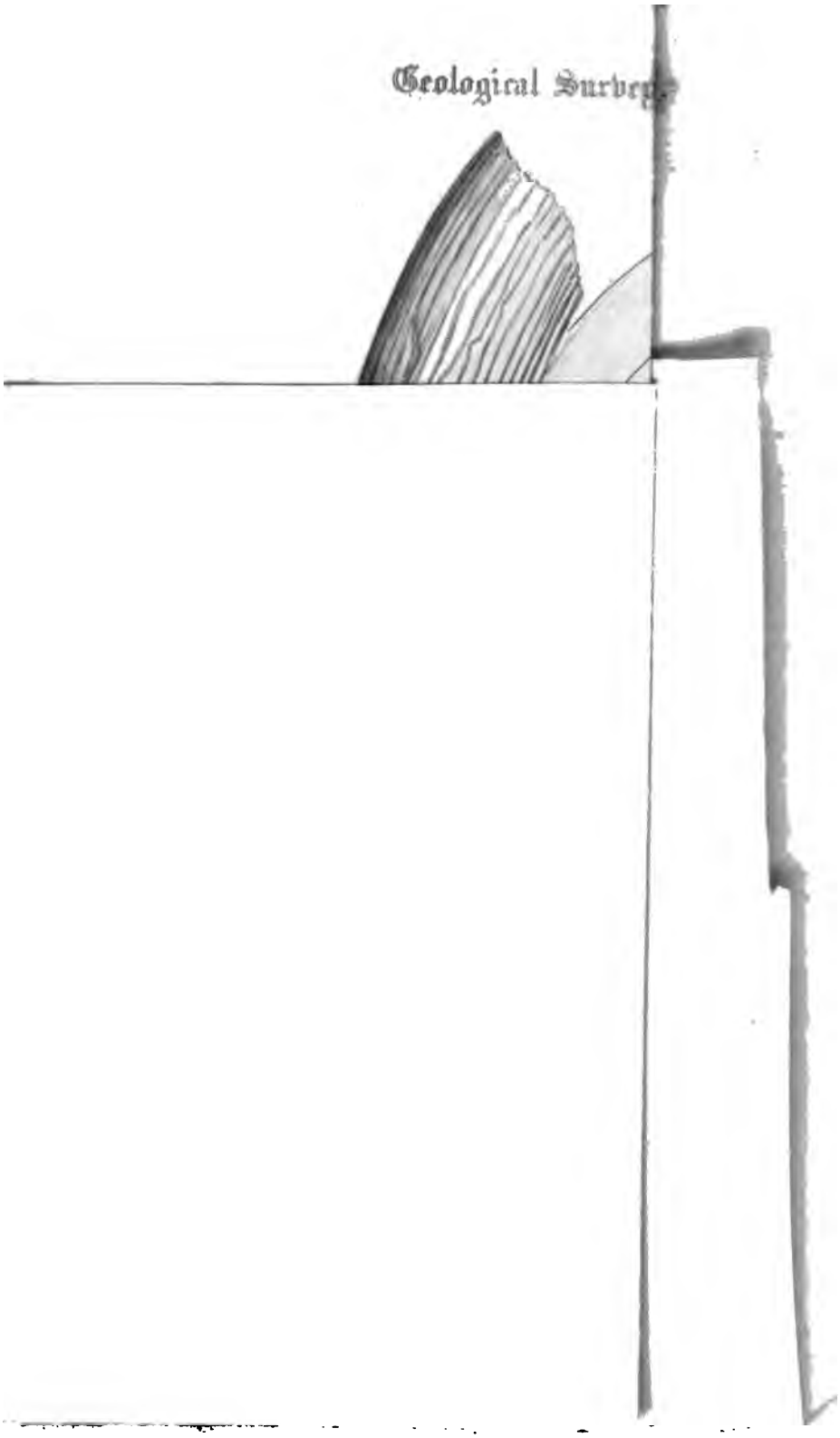
Fig. 1. *Phacops* (*Trimerocephalus*) *lævis*, Münster. Specimens from Knowl Hill, Newton Bushell. (Mr. Pengelly's cabinet.)

Figs. 2, 3. From the same locality and cabinet. Specimens in which the head has been disjointed from the body and reversed in position. (See also fig. 5.)

Fig. 4. Thoracic ring and tail from Mr. Vicary's cabinet.

Fig. 5. Original specimen figured by Sowerby in the Geol. Trans., 2nd series, vol. v. (Same locality.)

Fig. 6. *Phacops* (*Trimeroc.?*) *cryptophthalmus*, Emmr., from Nassau. Copy of Sandberger's figure to show the differences of the species. *P. cryptophthalmus* is often confounded with *P. lævis*.


Geological Survey

BRITISH FOSSILS.

DECADE XI. PLATE X.

PARADOXIDES DAVIDIS.

[Genus PARADOXIDES. (Sub-kingdom Articulata. Class Crustacea. Order Trilobita. Family Olenidæ.) Elongate, of many segments, with a broad head and spinous head-angles, often greatly extended. Glabella widely clavate, with the lower furrows complete across. Labrum soldered to the hypostome. Body rings flattened, 17 to 20 in number, produced into recurved spines. Tail small, of few segments. Range, primordial zone only.]

DIAGNOSIS. *P. sesquipedalis et ultra, maximus, glabellâ parum clavatâ, genis latiori, sulcis duobus solum perfectis, reliquis obsoletis. Oculi antrorsum positi. Thorax articulis* 19, *axe lato. Pleuræ subrectæ, apicibus recurvis; anticis brevissimis abrupte flexis, ultimis longissimis, fere parallelis. Cauda truncata, axi obscuro* 2–3 *annulato; gladiis lateralibus longissimis.*

SYNONYMS. *Paradoxides Davidis*, SALTER (1863), Quart. Journ. Geol. Soc. (1864), vol. XIX., p. 275, woodcut, and XX., pl. 13, fig. 1–3.

The genus *Paradoxides*, from its bulk, has necessarily attracted attention from the earliest times in which fossils have been observed and collected. Linnæus figured it, from Sweden, and Count Kinsky from Bohemia, in the 18th century, and the *Entomostracites paradoxissimus* was still the name under which Wahlenberg noticed it in his résumé of the Swedish Trilobites in 1821. Brongniart added to the typical form several species afterwards known as *Olenus* by Dalman, who did no more than uselessly change the name of the whole genus. And while the species were distinguished by subsequent observers, the new name *Olenus* seems to have been adopted till Bronn, in 1835, restored that which Brongniart had imposed. Zenker, in 1833, had suggested a division of this large genus, making the great *Paradoxides* the type of *Olenus*, and so reversing the original nomenclature. But Emmrich's essay did not second this idea, and it was left for Goldfuss, in his systematic review of the group (Jahrbuch, vol. v., 1843), to give their correct definition to these two genera, which have since been generally adopted.

The broad club-shaped glabella, large head spines, and numerous

(17 to 20) segments to the body, easily distinguish this group, which comprehends the largest Trilobites known, and yet is the earliest or nearly the earliest type of the whole Trilobite family. *Agnostus* accompanies it in all countries where it has been observed, and it is known to have ranged from N. America to Russia, and from Sweden to Spain and Bohemia. Twenty years ago a single specimen was found in the British slate rocks, and it is only within the last year or two that it has been found in any considerable numbers, in a single locality in South Wales. I had myself the good fortune to discover the new species, which was first figured in the Quarterly Geological Journal for 1863.

Description.—Of the head we have now many specimens, and some of the fragments betoken a fossil not less than 16 or 18 inches long; one or two heads are perfect, and show that it was semi-circular, with very large, thick, cylindrical, and tolerably straight spines. The glabella rather long, reaching and overhanging the front margin, broader but not suddenly so in front, half its length being occupied by the great front lobe.

There are obscure traces in some specimens of short anterior furrows, but I cannot be sure of more than the two complete posterior ones, which bend backwards in the middle, and are equally strong with the neck furrow. The eye is far forward, in advance even of the second or upper glabella-furrow, and is near the glabella,—not half its length distant from it. The cheek is coarsely granular, except toward the outer angle, and abruptly contracted beneath, at the base of the great cylindrical spine.

The labrum is expanded at the base, and has a truncated end, with sub-spinous lateral angles. It is, as usual, separated by scarcely any suture from the hypostome, or rather is connate with it.

I can, in a fine specimen lately found, count 19 body-rings, and believe this to be the full number. The axis is very wide (in the largest specimen 1½ inch) and convex, fully as wide in front as the pleuræ, spine included, and so for the eight or nine front segments. The apex of the pleuræ in these is abruptly turned back, with a short sharp mucro, and there is no enlargement of the second or third pleura—a character of importance in this genus. All have a deep groove, which is considerably oblique, and reaches the hinder margin just at the base of the spine in all the pleuræ. But from the eighth or ninth segment the pleuræ lengthen, and the axis gradually tapers. The hindermost axial ring is about half the width of the front ones, and scarcely one-fourth as wide as its long pointed pleuræ.

All the middle pleuræ have a strong curve backwards from the fulcral point, but at the same time arch outwards, and gradually, as they approach the tail, close in upon it until the hindermost are parallel with it. These hinder pleuræ are greatly lengthened, and are of two forms in two distinct varieties (possibly sexes?). In one form (fig. 4) the penultimate pleura is developed into a shorter spine than the preceding; and the last is suddenly abbreviated and incurved. This may be by abortion of the segments. In another the increment is regular, but the last spines are not extravagantly developed. In a third variety, the ultimate and penultimate pleuræ are greatly extended (fig. 7), and this is accompanied by a corresponding dilatation and lengthening of the caudal portion next to be described.

The tail in this species is most remarkable, and for some time I was inclined to believe that its outer segment was the ultimate pleura of the body. In fact, the front caudal ring is a very slightly metamorphosed body-joint, and is not very strongly connected with the tail piece; but it nevertheless belongs to it.

Exclusive of the great sabre-shaped lateral spines, which are three or four times its length, the tail is an oblong convex plate, with a short conical broad axis occupying about two-thirds of its length, and annulated by two or three incomplete rings. The extremity of this plate is broad and sharply truncate, contrasting with the parabolic contour of its axis, which is not so long as broad. The sword-shaped appendages are broader as well as longer than the last pleura of the body rings, and at first bend strongly inwards beneath the tail, afterwards diverging again at the tips (fig. 4). In one variety they are, in a moderate sized specimen, four inches long. They are connate with the central plate of the tail, though separated from it by a deep groove, except at the actual base, where the character of a pleura is maintained by the usual pleural groove running out into it.

The nearest approach to this structure is made by the *Paradoxides Bohemicus*. But in that species the enlarged last appendages are true pleuræ, according to Barrande's figure, and the tail itself is destitute of all appendages. Moreover, in that allied species the second pleura of the body is enlarged; so we have an additional character of separation from the present species.

In *P. spinosus*, Boeck, the glabella is shorter and the eye less curved and nearer the glabella. The unfurrowed portion of the pleuræ is shorter, and the hinder pleuræ are only straight, not sinuous.

Paradoxides Davidis nearly equals in dimensions the great *P. Harlani* from Massachusetts, and exceeds the large Newfoundland species described by me under the name of *P. Bennettii.** The three Swedish species are greatly inferior in size.

The above description is chiefly taken from the Quarterly Geol. Journal for the present year. In the plate accompanying that Memoir all the varieties are figured.

Locality and Geological Position.—LOWEST LINGULA FLAGS, Porth Rhaw and Solva Harbour, both near St. David's, South Wales. It has been lately detected at the Dolgelly gold mines, close to Pistyl-y-Cain, by Mr. Readwin, and by Mr. Ezekiel Williamson, an excellent observer.

P. FORCHHAMMERI. ?

PLATE X. FIG. 9.

SYNONYMS. *Paradoxides Forchhammeri*, ANGELIN, Palæontologia Suecica, t. 2 ? *Paradox. Forchhammeri*, SALTER, Siluria, 2nd ed. 1859, p. 45 ; Foss. 5, fig. 2, ib. ; Mem. Geol. Surv., vol. iii. ined., pl. 4, fig. 12.

Description.—Our specimen must, when perfect, have been fully 3½ inches long by 1½ broad. Of this length the long head is fully one inch, semi-oval, and with a long clavate glabella, which reaches quite to the front, and is rather broader than the cheeks. Below, the glabella is sub-linear, and not much above half as wide as in front. And it appears to have only the two lower complete transverse furrows ; the upper inflated portion, more than twice the length of the lower, being unmarked by any furrows, except a pair of very short ones marking the place of the middle lobes.† The eye is larger and placed further back on the cheek. The border of the head distinct and broad. Spines — ? (the outer angle of the cheek is lost, and we do not know what the spines may be).

Body with a long cylindrical axis tapering very slowly backwards, with straight sides. The axis-rings are not, even in the front part, more than thrice as wide as long, and at the twelfth ring not so much. We have only 15 of the body segments, and the pleuræ are equal and similar for the first eight rings at

* Quart. Journ. Geol. Soc., vol. xv. p. 553.

† Two pairs are marked out in the figure in Siluria above quoted. But there is hardly any warrant for this. The specimen is too imperfect to decide it fully.

least, the second or third not being at all visibly enlarged at the end.*

The pleuræ are wider than the axis by one-fifth, or less, and are but slightly curved, the tip acuminate, short, recurved, but not produced as in *P. Davidis*. We have only eight pleuræ, and cannot therefore determine the shape of the extremities of the hinder ones. But there is no appearance of enlargement in the seventh or eighth. The groove is very oblique, and runs into the short mucro, rather than ends abruptly behind its base. As M. Angelin's *P. Forchhammeri* wants the front body rings, and ours the hinder ones, it is not possible to institute a closer comparison.

Although very incomplete, enough remains to show that the species is distinct from any of the Bohemian ones, unless it may be *P. Bohemicus*, and from either of the three Swedish species described by Angelin, except *P. Forchhammeri*.

But there are several points in which it agrees with the latter species and differs from *P. Bohemicus*. The glabella is widely clavate, and the furrows across the base are parallel, or nearly so. The eye appears to be nearly in the right position, but this is obscure. The body rings, of which we have only 16 preserved, have the axis narrower than the pleuræ, and the latter have only short points, and very oblique grooves. The second pleura is not elongated, nor at all wider than the third, another point in which it differs from *P. Bohemicus*, but in which *P. Forchhammeri* does not offer means of comparison. But in the proportionate length to their width, the pleuræ agree much better with the Swedish species, the length being rather more than three times the width, while in *P. Bohemicus* it is rather less.

In both *P. spinosus* and *P. rotundatus* of Bohemia, and *P. Tessini* of Sweden, the two basal glabella furrows, besides the neck furrow, run quite strongly across. Our species does not need, therefore, comparison with them, as it has only one transverse groove above the neck furrow; the rest are very obscurely indicated in this specimen, which has been much compressed in an oblique direction. This will account for the narrow glabella.

Locality and Geological Position.—LOWER LINGULA FLAGS, North Wales (exact locality uncertain, probably near Dolgelly). Collected by A. Selwyn, Esq., 20 years back. (Mus. P. Geology.)

* Usually Bohemian species have the second ring enlarged. N. American species the third pleura. In *Anopolenus*, an allied genus, the hindermost 3 or 4 are all enlarged.

Explanation of Plate X.

Figs. 1-6. *Paradoxides Davidis*, Salter, various fragments from the Lower Lingula Flags of St. David's.

Fig. 1. Large glabella, showing two complete furrows, and one incomplete pair (this last is doubtful), and other specimens do not confirm it.

Fig. 2. Tolerably complete head, with the labrum, *a*, turned upward from the lower surface at *b*; the suture between the *labrum* and the *hypostome* is seen to be soldered.

Fig. 3. Labrum of large specimen.

Fig. 4. Hinder body rings showing the gradually lengthening points of the pleuræ, completed from more perfect specimens. (See Quart. Geol. Journ., 1864, vol. XX., pl. 13.) This variety has the last pleura abbreviated.

Fig. 5. Posterior body rings.

Fig. 6. (Not numbered on the plate.) Head spine of the largest specimen known.

All the above, except fig. 2, are in the Mus. Pract. Geology. Fig. 2 is in the cabinet of Mr. J. E. Lee, Caerleon. The ornament of its pleuræ is seen in the magnified figure.

Fig. 7. Outline, restored from the largest fragments, and nearly coinciding with the size of the largest and nearly perfect specimen since found, and placed in the British Museum.

Fig. 8. Body rings of a very large individual. (Mus. Pract. Geology.)

Fig. 9. *Paradoxides Forchhammeri*, Angelin? From the black Lingula flags of N. Wales, Locality unknown, probably Dolgelly. (Mus. Pract. Geology.)

J. W. Salter.

November 1864.

MEMOIRS

OF THE

GEOLOGICAL SURVEY

OF

THE UNITED KINGDOM.

Figures and Descriptions

ILLUSTRATIVE OF

BRITISH ORGANIC REMAINS.

DECADE XII.

ILLUSTRATIONS OF THE STRUCTURE OF THE CROSSOPTERYGIAN GANOIDS,

BY THOMAS H. HUXLEY, F.R.S.,

NATURALIST TO THE GEOLOGICAL SURVEY OF GREAT BRITAIN.

PUBLISHED BY ORDER OF THE LORDS COMMISSIONERS OF HER MAJESTY'S TREASURY.

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1866.

16295.

BRITISH FOSSILS.

DECADE THE TWELFTH.

ILLUSTRATIONS OF THE STRUCTURE OF THE CROSSOPTERYGIAN GANOIDS;

BY

THOMAS H. HUXLEY, F.R.S.

I.—THE GENUS GLYPTOPOMUS.

At p. 57 of the "Poissons Fossiles du Vieux Grès Rouge," Prof. Agassiz remarks, in establishing this genus, that he at first took the only specimen known to him for a *Platygnathus*; and it is figured in the 26th plate as *Platygnathus minor*. He describes the unique specimen of *Glyptopomus minor* in the following terms:—

"This fish, of which I know but a single specimen, obtained at Dura Den, and placed in the collection of Prof. Jameson, has the body wide and heavy, and resembling in form that of *Holoptychius*. It lies on its belly, and is turned a little to the left side, so that it is the back and right side which are visible. The head is proportionably small, and composed of enamelled and irregularly sculptured bones, which appear to be covered with a thick and very variable granulation. In the middle of the head it is easy to distinguish the frontals; in front, the nasals; behind, the occipital; and a great lateral enamelled plate, which indicates that the cheek was covered, as in *Polypterus*, by a single osseous lamella, below which the great masticatory muscle was fixed.

"The scales of the body are very considerable, very high on the sides, almost square on the back. They form oblique series, which meet at an acute angle in the middle line of the back. The scales themselves are very thick, placed side by side, apparently connected together only by the integument in which they were implanted. Their enamelled surface is not smooth, but adorned with a fine granulation, which gives them a velvety aspect. I have been unable to examine their microscopic structure.

"Only a few traces of fins are preserved in the specimen figured; probably a portion of the ventral near the throat, and a vestige of the dorsal, or caudal, near the end of the tail. The fin rays seem to have been short and delicate."

In the "Preliminary Essay" of the "Tenth Decade" I described and gave a woodcut of the skull, represented in Plate I., fig. 2, of the present decade; and in a note at the end of that

Essay, I briefly adverted to the addition made to our knowledge of the genus by the specimen received from Dr. Taylor of Elgin, which I now proceed to describe at length.

GLYPTOPOMUS MINOR. (Pl. I., fig. 1.)

This is a cast, in tolerably fine-grained sandstone, of an entire specimen of *Glyptopomus*, the parts of which have undergone very little derangement. The sandstone block in which the fish has been preserved is split into two slabs, along a plane traversing the body of the fish, and, in general, midway between its dorsal and ventral surfaces. The one slab (fig. 1, Pl. I.) therefore, contains, for the most part, the impression of the dorsal surface of the fish, while the other exhibits the impression of its ventral surface; but the plane of splitting has not traversed the head, so that the impression of the jugular plates and lower jaw is left on both slabs. On the one, or dorsal slab, however, it is the impress of the inner surface of the bone of these parts which is shown, while, on the other, the outer or sculptured surface has left its mark.

The total length of the body of this fish is $13\frac{3}{4}$ inches; it attains its greatest width ($2\frac{3}{4}$ inches) in the middle of its length. Some allowance must be made, however, for the compression to which the fish has been subjected.

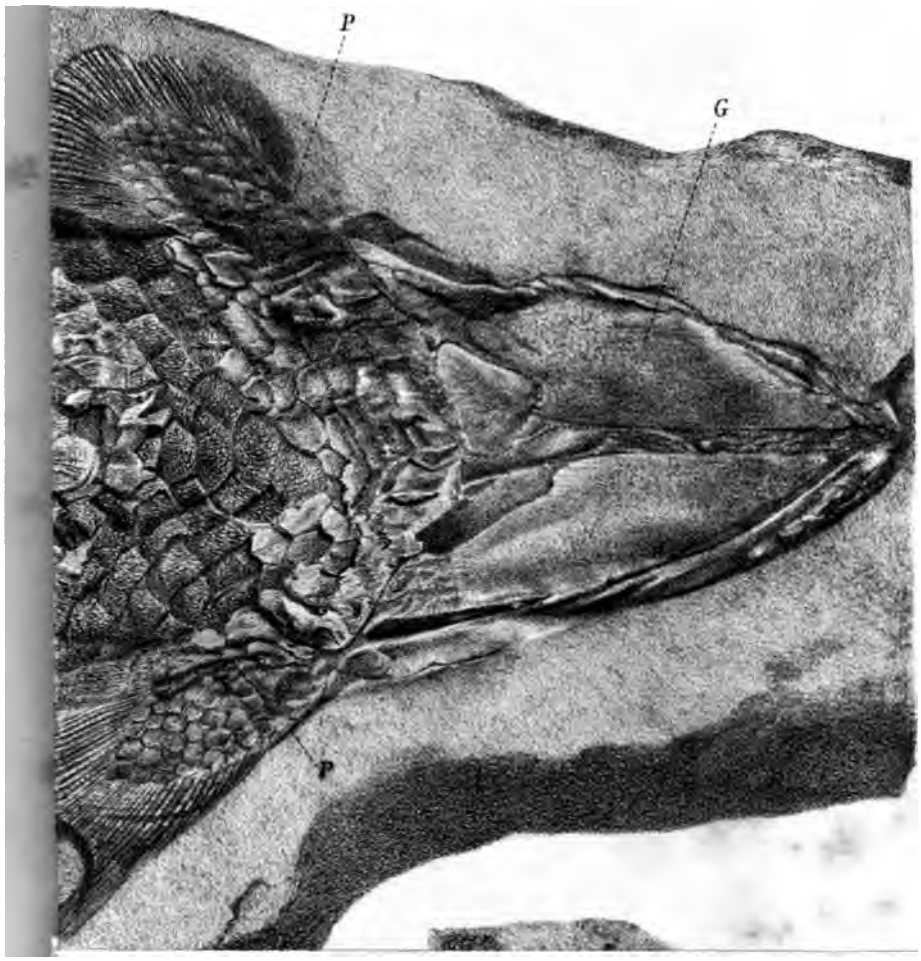
The greatest length of the head, measured in the middle line, from the anterior end of the snout to the level of the posterior margins of the opercular apparatus, is $2\frac{3}{4}$ inches, or about one-fifth the length of the body.

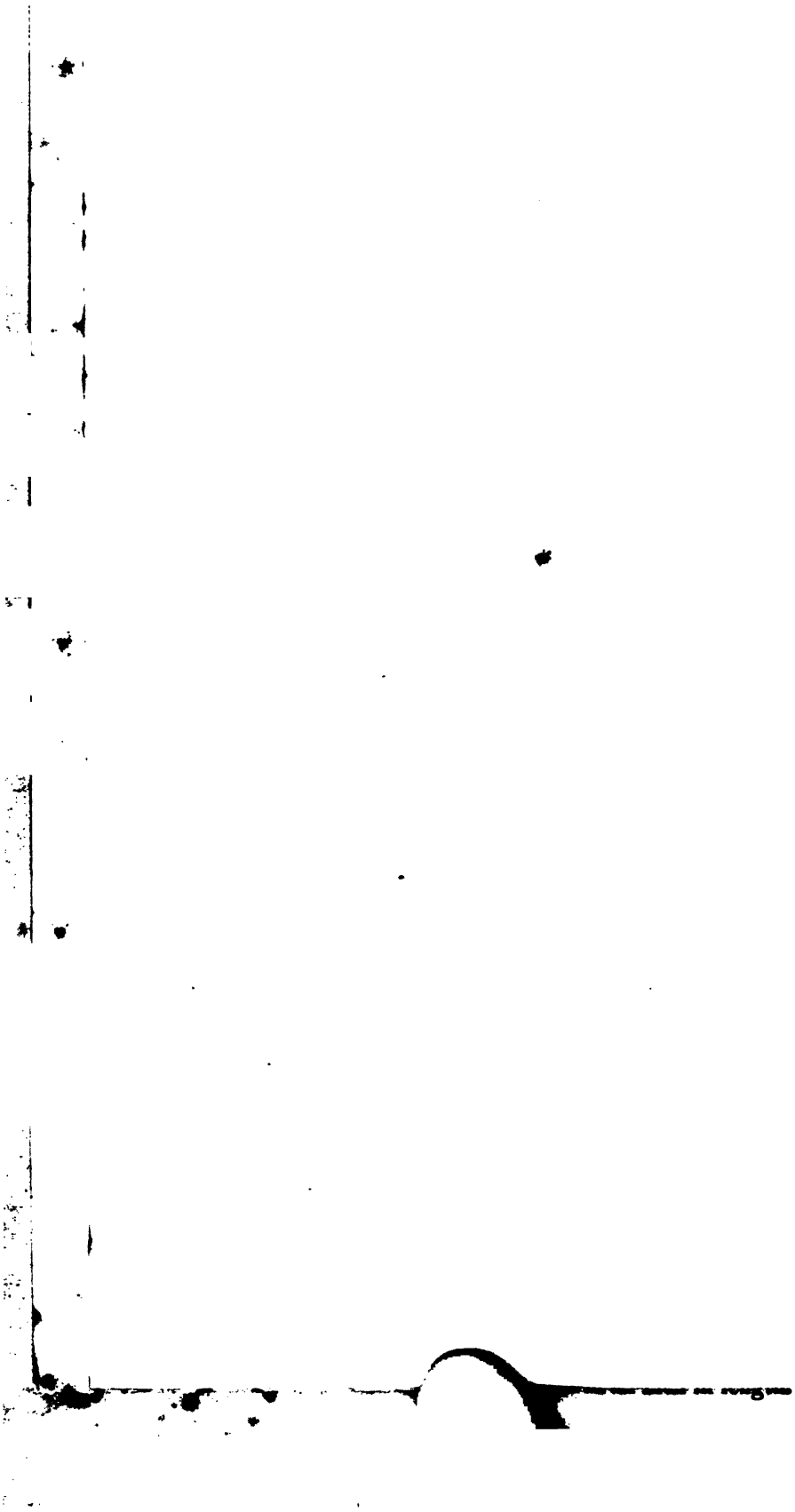
The principal jugular plates (*G*) are each 2 inches long by about three-quarters of an inch wide at widest. The impression of their surfaces shows that they had had a finely-ridged, more or less granular, sculpture. There is no median jugular plate, and there is no positive evidence of the existence of any lateral jugular plates.

Behind, and partially overlapped by, the two principal jugular plates there is evidence of two triangular sculptured plates belonging to the pectoral arch; and behind these commence the series of ventral scales, which are irregularly four-sided, about a quarter of an inch wide by one-sixth of an inch long, and are disposed in transverse rows, which converge obliquely from above and without, downwards and inwards, to the middle line. The surface of the cast of each scale exhibits a multitude of minute hemispherical elevations, corresponding with the pits which constitute the well-known ornamentation of the scales of this genus.

The median dorsal scales are irregularly hexagonal, and the rows of lateral dorsal scales run from them as a centre, downwards and backwards, on each side, to pass into the lateral ventral series. The most anterior and largest of these median scales are as much as four-tenths of an inch wide by a quarter of an inch in length.

Fig. 1.





The general character of the sculpture is the same on the dorsal as on the ventral scales. On the right side of the body some few of the scales in the position of the lateral line exhibit a grooved character, which is somewhat more prominent in the figure than it appears to my eye to be in nature.

The impression of the anterior dorsal fin (*D*) commences at seven inches and three-tenths from the anterior extremity of the muzzle; that of the second dorsal (D^1) at about nine inches and a half from the same point.

The fin rays of the ventrals (*V*) are visible on one side in the dorsal impression (fig. 1), and, on both sides, in the ventral cast, just in front of the second dorsal. They seem to have been broad, but far shorter than the pectorals, and the impressions are so indistinct that I cannot say whether they are lobate or not.

The pectoral fins (*P*, P_1) are exquisitely displayed; each has a broad scaly lobe, subacute at the extremity, and more than an inch long, by half an inch wide. The scales exhibit the same sculpture as those on the body, but are much smaller, and diminish in size towards the apex of the lobe. The many-jointed fin rays are attached all round the margins of the lobe, and become longer towards its apex, where they form fully half of the length of the fin.

I see no trace of the anal fin in either slab. The impression of the well-defined upper lobe of the caudal (*C*) commences at eleven inches and a quarter from the anterior extremity of the muzzle. The lower lobe is not well shown in either slab; but I suspect from the size of the upper, that the tail is diphycercal.

The only tooth of *Glyptopomus* I have seen, fig. 4, is stout, conical, slightly curved, and deeply grooved longitudinally.

The jugular plates and the mandibles have a coarsely pitted and ridged sculpture (Pl. I., fig. 3).

These facts leave no doubt as to the position of *Glyptopomus* in the Glyptodipterine family of the suborder *Crossopterygidæ* among the *Ganoidei*.

Description of Plate I.

Fig. 1. The cast of a specimen of *Glyptopomus minor*. In Dr. Taylor's Collection. *Nat. size.*

Fig. 2. The skull of a larger *Glyptopomus* viewed from above. It is described in Decade X. "Introductory Essay," p. 4. In the British Museum. *Two-thirds of the size of nature.*

Fig. 3. A fragment showing the sculpture of the jugular plates (*G*) and the mandible (*Mn*). In the Museum of Practical Geology. *Nat. size.*

Fig. 6. A slab with well preserved scales and a tooth of *Glyptopomus*. *Nat. size.* The tooth and one of the scales are represented separately and magnified.

II.—Illustrations of the Structure of the Cœlacanthini.

1. *The genera* Cœlacanthus *and* Undina.

In the "Preliminary Essay upon the Systematic Arrangement of the Fishes of the Devonian Epoch," prefixed to the tenth decade of the "Figures and Descriptions illustrating British Organic Remains" (1861), I have endeavoured to prove that the genera *Cœlacanthus*, *Undina*, and *Macropoma* constitute a very distinct family of the Crossopterygian Ganoids, to which the term *Cœlacanthini* ought to be restricted.

At the time of the publication of this essay I was unaware that, in 1858, the late eminent palæontologist, M. Thiollière, had enunciated the same conclusion in the following terms:—

"La famille des Célacanthes comprendrait à la fois, suivant son auteur, les *Sudis* de la faune actuelle, le *Glyptolepis leptopterus* du vieux grès rouge, et le *Cœlacanthus granulosus* du terrain permien. Ce sont pourtant là trois types ichthyologiques beaucoup trop différents pour être ainsi réunis. Mais, si l'on exclut les deux premiers et qu'on associe au genre *Cœlacanthus* lui-même les *Macropoma* de la craie et les *Undina* du Jura, on obtiendra le noyau d'une famille réellement naturelle, et que, pour éviter la confusion, M. Thiollière désignera par le nom d'*Ortho-célacanthes*." *

It is to be regretted that only the abstract of this paper has been published, as it would have been very interesting to learn the grounds upon which M. Thiollière's conclusion is based, and which are not stated in the "Note" whence the foregoing passage is extracted.

My own view of the common characters of these genera is given in the following definition of the suborder *Crossopterygidæ* and family *Cœlacanthini* ("Preliminary Essay," p. 26).

Suborder CROSSOPTERYGIDÆ.

Dorsal fins two, or if single multifid or very long; the pectoral and, usually, the ventral fins lobate; no branchiostegal rays, but two principal, with sometimes lateral and median, jugular plates situated between the rami of the mandible; caudal fin diphycercal or heterocercal; scales cycloid or rhomboid, smooth or sculptured.

Fam. Cœlacanthini.

Dorsal fins two, each supported by a single interspinous bone; paired fins obtusely lobate; air-bladder ossified.

Since 1861 I have studied a considerable number of specimens

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* *Note sur les poissons fossiles du Bugey, et sur l'application de la Méthode de Cuvier à leur classement*; par M. Thiollière. Printed in abstract in the "Bulletin de la Société Géologique de France," Sc. 2, I. xv., pp. 782–793, 1858.

of Cœlacanthines belonging to the genera *Cœlacanthus* and *Macropoma*, without finding any reason to modify the definitions just given; but the materials which have passed through my hands enable me to illustrate the structure of these genera more fully than has hitherto been possible.

I commence these illustrations with the genus *Cœlacanthus*, for the opportunity of examining numerous specimens of which I am indebted to the Earl of Enniskillen, Sir Philip Grey Egerton, Bart., Dr. Rankine, of Carluke, Edward Binney, Esq., F.R.S, of Manchester, Dr. Garner, and Messrs. Molyneux, Ward, and Weston.

The Genus CŒLACANTHUS, Agassiz.

The name *Cœlacanthus* was first applied to a genus of fossil fishes by Agassiz, in the feuilleton of his "Recherches sur les Poissons fossiles," dated March 1836*; and figures of the fragments from the Magnesian Limestone of Durham, to which he applied the title of *Cœlacanthus granulatus*, were published in 1839, in Plate 62 of the second volume of that work.

Furthermore, in the systematic catalogue of the fossil fishes in the collections of Lord Enniskillen and Sir Philip Egerton, the family *Célacanthes* had been established for the genera *Cœlacanthus*, *Holoptychius*, and *Macropoma*, with two additional species of *Cœlacanthus*, *C. lepturus* and *C. gracilis*, from the Carboniferous formation.

But no description of these specimens, or diagnoses of the genera, had appeared in 1842, when Count Münster published the fifth part of his "Beiträge zur Petrefacten-Kunde," containing figures and descriptions of the fishes from the Lithographic slates which he names *Cœlacanthus striolaris* and *C. Köhleri*.

Count Münster, however, had already published notices of these fishes in Bronn's "Jahrbuch," for 1842, and had applied the generic title of *Undina* to them. And he remarks, that if Agassiz' genus *Cœlacanthus* from the older formations is provided, like *Macropoma*, with conical teeth, the otherwise very similar fishes from the Lithographic slates would belong to a different genus, for which the title of *Undina* might be retained.

With this proviso Münster continues his description, as follows:—

"Genus CŒLACANTHUS, Agassiz.†

"Teeth flat, strongly granulated: scales thin, elongated, rounded off: two dorsal fins: caudal fin very large and broad, vertebral column traversing the middle of it, and forming at its point a second small pencil-like fin. Skeleton, with the exception of the vertebral column, bony; body elongated.

"1. *Cœlacanthus striolaris* . . . . . .

I am acquainted with four specimens of this species, all of which were found at Kelheim, on the right bank of the Danube. The largest of them in my collection, measures a foot (Rhenish) from the head to the tip of the tail, and three inches five lines in breadth, without the fins; the smallest specimen, in which the apex of the head is wanting, is nine inches long and two inches six lines broad. The former is depicted in the second plate, but, since the thoracic and abdominal fins are not well preserved in the original, I have supplied these parts in the figure from other specimens. Both specimens, as well as a third, which I have had the opportunity of examining, lie upon one side, and exhibit a slightly convex back and an almost straight ventral line. The head is small, the forehead strongly arched; the bones of the head, however, are very brittle, and hence are badly preserved. Of the teeth only a few, as well

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* *See* Count Münster's "Beitrage" Heft, V. 1842.

† The references to the figures are, for the most part, omitted in this translation.

in the upper as in the lower jaw, are visible, and are seen, above, from the side, below, from the upper surface. Whether more than one series exists is not clearly discernible. The most distinct are a few teeth of the lower jaw, which are represented magnified in figure 8, have an angular flat form, and are strongly granular upon their upper surface; within these teeth a few others which were more rounded off appear to have been implanted in the lower jaw. The bone of the jaw, however, is so brittle that no more exact determination of this point can be made.

"The scales are relatively large, but so thin and so closely united together, that in a few spots, especially towards and amidst the caudal fin, they appear like a finely-striated membrane. . . . . .

"They all exhibit fine, short, elevated ridges, and only the cervical scales are somewhat granular at their external ends. But the peculiar fins most especially characterize this fish.

"The first of the two dorsal fins, which lies over the pectoral fin, has eight simple rays, which, in their proximal halves, are deeply grooved, thick, and crenulated on the outer edge; on the upper side, towards the point, however, they are flat and closely jointed. The second dorsal fin has 13 or 14 flat, closely-jointed, rays, somewhat depressed in their middle part and grooved towards the root. This fin is placed directly over the anal fin, which has a perfectly similar size and composition. Fig. 14 depicts one of the median rays. The ventral fin is small, but indistinct and weathered. The pectoral fin has 13 or 14 flat closely-articulated rays, just like the two dorsal and the ventral fins. Most remarkable, however, is the broad caudal fin, which is divided by the unossified vertebral column into two halves, the upper of which bears 20–21 rays, the lower 18–19, which form prolongations of the vertebral processes. The outer side of the deeply-grooved rays is very finely notched, almost toothed; the thick spinal column forms, at the end of the two caudal fins, a pointed pencil-like second caudal fin, with 20 or 30 short flat closely-jointed rays. The unossified spinal column is finely striated; in the middle of it very short bones in pairs appear. The spinous processes are continued along the whole dorsum of the spinal column. Neither ribs nor special bodies of vertebræ are visible. In these specimens the stomach of the fish is rendered obvious by a depression, with a smooth shell-like investment, like what may be seen in most specimens of *Macropoma Mantelli*.

"2. *Cœlacanthus Kohleri*. . . . . .

"I know of only one imperfect specimen of this species, for which I am indebted to the kindness of M. Kohler. The greater part of the head, with the pectoral and ventral fin of this individual, are wanting. It was at least one-third larger than the largest specimen of the preceding species, from which it is especially distinguished by its scales, which are covered with raised elongated points, almost like flies' eggs. The few scales whose external form is recognizable, resemble those of the preceding species, but are larger, and have elongated granulations upon their surface.

"The fins closely resemble those of the foregoing species. The first dorsal has nine thick rays, which are very long, and are distinguished from those of the preceding species by the rows of small spines which beset their outer sides as far as the middle. . . . . The point is flat and closely articulated.

"The second dorsal has 19 or 20 very broad, sharp-pointed rays, which are so close together that they come into contact in the middle.

"The anal fin is constructed like the preceding.

"The broad caudal fin is distinguished from that of the preceding species by a greater number of rays, and especially by many series of small spines on the outer side of the rays, as fig. 17 shows. In this species also the stomach with its smooth coat is visible."

Another species of *Cœlacanthus*, from the Kupferschiefer of Richelsdorf, is described by Count Münster, at p. 49 of the same part of his "Beiträge," under the name of *Cœlacanthus Hassiæ*. Though only a damaged skeleton without scales, it agrees closely, in general form as well as in its essential details, with *Cœlacanthus striolaris*.

The teeth are not recognizable. A few large scales lie scattered about. They are very large, but so thin that their proper form is not clearly distinguishable. However, they are all rounded off, smooth, raised from the exterior towards the middle, and correspondingly depressed below.

The anterior dorsal fin possesses ten very long, strong, simple rays, which are somewhat crenulated on the outer side, and jointed towards their end. The second dorsal fin has much finer articulated rays. The great ventral fin has long laterally crenulated rays; the vertebral column is unossified; the spinous processes of the vertebræ are only to be seen distinctly on the dorsal side of the vertebral column, and increase in size towards the tail.

It is clear from these descriptions that Count Münster was the first to indicate and define most of the great features of the organization of the Cœlacanthines, viz., the unossified vertebral column; the absent ribs; the shelly-walled internal organ, "like that of *Macropoma*"; the well-ossified head; the two dorsal fins; and the remarkable tail, with the singular characters of the fin rays.

Professor Agassiz first published his views respecting the Cœlacanths in 1843, when the second part of the second volume of the "Recherches sur les Poissons Fossiles" appeared.

In treating of the "Family of the Cœlacanths," he writes, at p. 168 of this work, as follows:

"THE FAMILY OF THE CŒLACANTHS.

"I unite in this family many genera of an altogether peculiar physiognomy, but with whose true affinities I am, as yet, only very imperfectly acquainted. A remarkable peculiarity which has struck me in most of these fish, is the circumstance that their bones, and notably their fin rays, are all hollow internally, a peculiarity which is not met with in other ganoids, and which is the origin of the name "Cœlacanth" which has been conferred on the family. This character is especially striking in the true genus *Cœlacanthus*. To this singular structure of the bones is added another more apparent and more external character, viz., the form and disposition of the fins, and the mode of articulation of the rays; and, in the first place, most of the rays are stiff, or only articulated at their ends. Their combination with the apophyses [neural arches and spines] and inter-apophysial [inter-spinous] bones, is very singular,

especially in the caudal fin, the rays of which are supported by interspinous bones; an arrangement which, in other fishes, is found ordinarily only in the anal and the dorsal [*caudale* in the text]. Lastly, the vertebral column is prolonged, more or less distinctly, between the principal lobes of the caudal fin, so as to form a median taper process."

Professor Agassiz then adverts to the resemblances and differences between *Cœlacanthus* and *Macropoma*, in a passage which I shall cite hereafter, and proceeds:

"Taking into account the extraordinary development of the dentary system in some genera of this family, and particularly in *Holoptychius*, one is tempted to approximate the Cœlacanths to the Sauroids; whilst the dentition of the genus *Undina*, as it has been described by Prof. Münster, would seem to establish a closer affinity with the Pycnodonts. On the other hand, the scales exhibit peculiarities which are to be met with in no other family, whence I have been disposed to arrange the Cœlacanths provisionally between the Sauroids and the Pycnodonts. It may be, however, that their true place is near the Scleroderms, or the *Accipenseridæ*."

Of the genus *Cœlacanthus* itself, Professor Agassiz remarks (p. 170):

"This genus, which I regard as the type of the family, was long known to me only by fragments; but these were so different from most other ichthyolites, that I did not hesitate to form them into a distinct genus. What especially struck me was the form and the structure of the fins, their relation with the interspinous bones, and the manner in which the apophyses [vertebral arches and spines] are united on the one hand with the bodies of the vertebræ, and on the other with the interapophysial [interspinous] bones. The apophyses divide at their bases into two branches, forming a fork, which embraces the body of the vertebra; to this apophysis succeeds an ossicle, which, instead of being interposed between two apophyses, is fitted on to the end of one, so as to form its direct prolongation. The ray properly so called, the longest of the three pieces, is also forked at its base; its extremity alone is jointed, but never bifurcated. These three pieces, the apophysis, the inter-apophysial bone, and the ray, are about equal in length, and are all three hollow. . . . . This singular structure characterises most of the rays which lie at the posterior part of the body; now as, usually, only the anal and the dorsal have inter-apophysial bones, I at first concluded that these two fins must be excessively developed; and what helped to strengthen me in this idea, was the fact that the vertebral column appeared to be continued beyond the two azgyos fins, to form, further on, a bundle of very small articulated rays, attached directly to the vertebræ. But Lord Enniskillen's discovery of an entire specimen of this remarkable type has completely modified my views. It now appears that besides the fins of so exceptional a structure, which I regarded as anal and dorsal, this fish has a very distinct normal anal and two dorsals. Now, unless the existence of three dorsal and two anal fins of very different structure —an arrangement which occurs in no known genus of fishes—be admitted, it is necessary to regard the terminal fin of the body as a caudal. For the rest, this is not the only known example of a caudal supported by inter-apophysial bones, the caudal of *Polypterus bichir* being supported by similar bones, at least its upper lobe. What is truly exceptional is the prolongation of the tail beyond these rays, and the little fascicle of articulated rays surrounding its extremity. In this

respect my genus *Cœlacanthus* very nearly approaches the type of a fish from the Lithographic limestone of Kehlheim, for which Count Münster has proposed the generic name of *Undina*. But notwithstanding this analogy, and the altogether similar disposition of the other fins, the fish in question is distinguished by many peculiarities which do not permit it to be confounded with *Cœlacanthus*. The most important difference is presented by the dentition. The genus *Undina* has, according to Münster, pavement-like teeth, very similar to those of certain Pycnodonts. *Cœlacanthus*, on the other hand, has conical teeth, like the Sauroids, and everything leads to the belief that it is a carnivorous fish, so that, far from belonging to the same genus, it is doubtful whether it belongs to the same family. Leaving the caudal aside, the other fins of the genus *Cœlacanthus* present a very simple structure, composed of slender but not dichotomous rays. The first dorsal corresponds to the extremity of the pectorals. The second is opposite the space between the ventrals and the anal. The anal itself is very closely approximated to the caudal. This last fin (comprising in it the bundle of articulated rays which fringes the extremity of the vertebral column) nearly equals one-third of the total length of the fish. The vertebræ are much higher than they are long towards the anterior part of the trunk, but they become sensibly elongated posteriorly. It is the same with the apophyses, which, very slender in the abdominal region, take on a much greater development in the caudal region. The scales, to judge by the fragment of *C. granulosus*, are large, elongated, and have their posterior edge rounded. I have not been able to ascertain whether they are enamelled or not, but the fact that they are found in strata older than the Jura leads me to suppose that, as in all the fishes of that age, they were enamelled. Their extreme thinness, no doubt, has made them too fragile to be often preserved. I conclude from this description that the genus *Cœlacanthus*, although near the genus *Undina* of Count Münster, is nevertheless different from it, and that the latter should therefore form a separate type in the Cœlacanth family. Consequently it will be necessary to exclude from *Cœlacanthus*, and to place in *Undina*, the remarkable species which Count Munster has described and figured in the fifth part of his "Beiträge," under the names of *Cœlacanthus striolaris* and *Köhleri*. The true genus *Cœlacanthus* is at present restricted to the coal, the Zechstein and the Muschelkalk. I am acquainted with six species.

"*Cœlacanthus granulosus*, Agass.- (Vol. 2, Tab. 62).

"The species to which I give this name was for a long time the only one known, and the two fragments which are figured were the only representatives of this remarkable family. Both represent the posterior part of a fish of very large size, which, to judge by the relative position of its fins, ought to have been at least two feet long . . . . . As a general rule the apophyses (neural spines and arches) and the inter-apophysial bones are equal in length. The rays, on the other hand, are a little longer, but they are never jointed down to their bases. The cleft of the ray into which the point of the inter-apophysial bone is inserted is much narrower than that of the apophysis (neural arch), which embraces the vertebral column. It is probable, from all I have been able to see, that, in reality, these anomalous rays are composed of filaments [*filets*], as in most other fishes, only these filaments do not become separate. The rays at the extremity of the caudal fin are exceptions to the general rule, inasmuch as they are directly attached to the vertebral column, without being borne either by an apophysis, or

an inter-apophysial bone. They are articulated, and appeared to be divided at their apices. It is these little rays which I considered, at first, to belong to the true caudal fin. I have explained above, in speaking of the genus, the reasons which have led me to withdraw this opinion, when I had the good fortune to discover a complete specimen of the type in the collection of Lord Enniskillen. Thanks to this discovery, I have been able to investigate the form of the vertebræ, which I found very massive, like the rest of the vertebral column. It has also led me to consider as a caudal fin all that great fin, borne by interapophysial bones, above and below the extremity of the tail; and, as an anal, the simple fin which precedes them below. The anal is composed of much more delicate rays, which, however, equally possess the peculiarity of being bifurcated and articulated only at their ends. The anterior ones are completely undivided.

"The granular spots observable here and there on our specimens are remains of the integument. I have seen fragments of scales only in a portion of another species of Cœlacanth, and from their structure I do not doubt that our *Cœlacanthus granulosus* was covered with similar scales. They are very delicate, and the concentric rings are very readily distinguished in them. The raised granulations which ornament their surface have originated the name *C. granulosus*, which I have given to this species.

"It was found in the Magnesiam limestone of East Hickley, and the originals of the plate are in M. Witham's collection.

"The species the description of which I reserve for the future, are—

"1°. *Cœlacanthus Phillipsii*, Agass. The caudal is more rounded than in *C. granulosus*, its rays are more close set and jointed nearer to their (proximal) ends. The apophyses of the caudal vertebræ are very long and delicate. The scales are large, and rounded posteriorly. From the Carboniferous rocks of Halifax.

"2°. *Cœlacanthus minor*, Agass. A very small species, remarkable for its very short inter-apophysial bones. The joints of the rays, properly so called, are longer than wide. The whole caudal is scarcely more than an inch long. From the Muschelkalk of Luneville.

"3°. *Cœlacanthus gracilis*, Agass. A species of unknown origin, distinguished by its elongated form; the pedicle of the tail, in particular, tapers evenly [*est tout d'une venue*], and its rays are less close set than in the other species.

"4°. *Cœlacanthus lepturus*, Agass. From the coal of Leeds. This species is still smaller than *C. minor*; its scales have rugose surfaces.

"5°. *Cœlacanthus Münsteri*, Agass. A beautiful species from the coal of Lebach, discovered by Lord Enniskillen, and characterized by its heavy form. It is in this species that I first saw the conical and hooked teeth of the genus *Cœlacanthus*."

The ascription of ossified vertebræ to *Cœlacanthus* is certainly erroneous, and in the "Preliminary Essay" (l. c. p. 16), I have already given the reasons which lead me to demur to Professor Agassiz's views regarding the systematic position and affinities of the Cœlacanths. Furthermore I have shown that "*Cœlacanthus*" *Münsteri* is not a *Cœlacanthus*; and, consequently, that so far as the arguments in favour of an essential difference between the dentition of *Undina* and *Cœlacanthus* are based upon the dentition of that fish, they are untenable.

In Professor King's "Monograph of the Permian Fossils,"

(1850), Sir Philip Egerton describes and figures a specimen of *Cœlacanthus granulatus* in his own collection.

"It shows little more of the fish than the figures given by Agassiz; but the scales are in a better state of preservation; they are irregularly rounded, and marked by fine undulating concentric lines. The enamel is thickly covered with the granulations which suggested the specific name. The second dorsal fin is also shown; it seems to have been larger and the rays thicker than in the anal fin opposed to it. The extremity of the tail is dislocated, and is seen in the lower part of the plate," p. 235.

The next page of the work cited contains the description of—

"*Cœlacanthus caudalis.*

"There is a charming little specimen, in the possession of Lord Enniskillen, of a Cœlacanth, which I am inclined to think can scarcely be referred to the preceding species. The entire length does not equal that of the tail of the smallest specimen of *Cœlacanthus granulatus* I have seen. The latter species is supposed by Agassiz to have been two feet in length; this fish measures only five inches. The head is rather more than a fifth of the total length; the second fifth includes the first dorsal, the third fifth extends to the back of the second dorsal, and from thence to the end of tail, occupies the two remaining fifths. This large proportion of the caudal region inclines me to adopt the specific name given above. The body is slender and of uniform size. The first dorsal fin is composed of about eight strong rays; these are carried upon thick inter-apophyses; and the corresponding neurapophysial elements of the vertebræ are enlarged to support them. The same arrangement is seen in the second dorsal, but the fin rays are more slender and more numerous. The pectoral, ventral, and anal fins are of moderate dimensions and slender structure. The tail is broader, and terminates more abruptly, than that organ in *Cœlacanthus granulatus.*"

The only other descriptions of Cœlacanths (other than *Macropoma*) of which I have any knowledge, are contained in the following brief notes upon Carboniferous fishes of the United States, entitled "Description of several new genera and species of Fossil Fish from the Carboniferous Strata of Ohio," by Dr. Newberry, contained in the "Proceedings of the Academy of Natural Sciences of Philadelphia," vol. viii. p. 98, 1854.

"CŒLACANTHUS, Agass."

"1. C. ROBUSTUS, Newb. Body robust, 1 foot 6 inches in length; upper surface of cranium covered with small closely-approximated tubercles, maxillaries and opercula threaded with fine parallel, sometimes interrupted, lines. Margin of opercula in mature specimens wavy.

"Scales elliptical, thin, 7 to 9 lines in length, nearly half the surface exposed; exposed portion covered with thread-like lines, similar to those of the opercula and maxillaries, and which converge towards the posterior angle of the scale.

"C. ORNATUS, Newb. Body, fusiform, slender, scarcely wider

than the head; size small, not exceeding 4 to 5 inches in length; upper surface of head ornamented with tubercles, which are much larger and more remote than in preceding species; opercula and maxillaries threaded, and like the scales, having stronger markings than in the larger species.

"Radial formula, A.D. 8; P.D. 5; C. 24?; A. 6; V.?; P.?.

"C. ELEGANS, Newb. Body fusiform, robust, 6 to 8 inches in length; cranial surface covered with closely-approximated tubercles; surface of opercular and maxillary bones threaded. All the ornamenting of the head relatively stronger than in *C. robustus*, but less so than in *C. ornatus*. Scales similar in form and markings to those of both these species, but more delicate than either. Anterior dorsal fin slightly in advance of ventrals; posterior dorsal as much forward of anal fin.

"Radial formula, A.D. 7?; P.D. 5; C. 22; A. 6; V. 9?."

In the course of the preceding history of the gradual discrimination of the forms which constitute the genera *Cœlacanthus* and *Undina*, the following species have been mentioned:—

Genus.	Species.	Formation.
		CARBONIFEROUS.
Cœlacanthus	1. *lepturus*, Agassiz.	
	2. *Phillipsii*, Agassiz.	
	3. *robustus*, Newberry.	
	4. *ornatus*, Newberry.	
	5. *elegans*, Newberry.	
		PERMIAN.
	6. *granulatus*, Agassiz.	
	7. *Hassiæ*, Münster.	
	8. *caudalis*, Egerton.	
		TRIASSIC.
	9. *minor*, Agassiz.	
		OOLITIC.
Undina	10. *striolaris*, Münster.	
	11. *Kohleri*, Münster.	

Besides these there are *Cœlacanthus gracilis*, Ag. of unknown locality and formation, and the so-called "*Cœlacanthus*" *Münsteri*, which must be excluded from the genus *Cœlacanthus*.

To the important question, how many of these nominal species are truly distinct, and what are their diagnostic characters, I must confess myself unable to give any satisfactory reply.

I have examined the specimens originally named *Cœlacanthus lepturus* by Agassiz, in Lord Enniskillen's collection, and I entertain no doubt that the specimens from the Staffordshire coal-field described in the present decade are specifically identical with these; but I can find no certain diagnosis by which this species is to be distinguished from the *C. elegans* of Newbery (though I by no means affirm the identity of the two), and I have not seen *C. Phillipsii*, *C. robustus*, and *C. ornatus*.

I have examined specimens of *C. Hassiæ* and *C. granulatus* in Lord Enniskillen's collection. They are undoubted Cœlacanths, a specimen of *C. Hassiæ* exhibiting the characteristic anterior dorsal interspinous bone, but no scales were preserved in any of the examples, nor were they in such a state as to allow of any useful comparison of the proportions of the body and fins.

C. caudalis is discussed below. Of *C. minor* I have seen no specimen, and Prof. Agassiz' diagnosis is insufficient to enable me to give any opinion concerning its specific distinctness.

Again, the differences between the genera *Cœlacanthus* and *Undina* appear to me to be anything but clearly made out. The close similarity of the two genera in the broad features of their structure is indubitable; and it is open to doubt whether the differences in the dentition are not more apparent than real.

Under these circumstances I shall adopt the generic and specific names, which have been used by my predecessors, provisionally, and without intending, for the present, to express any opinion as to their real value.

I. Cœlacanthus lepturus, Agassiz.

No. 1. *The specimen represented in Pl. II., figs.* 1, 2, 3, 4.

This fossil fish is nearly entire, only a small portion of its caudal extremity being absent. Its total length could not have exceeded five inches.

The length of the head appears to have been about 1·3 in., but the snout is somewhat crushed, and the occipital boundary is but indistinctly indicated.

The depth of the body, at the level of the anterior edge of the anterior dorsal fin (*D*) is 0·95 in. The anterior dorsal fin itself is 0·75 in. distant from the occiput, and 0·2 in. broad at its base. Twelve stout fin rays can be counted in it, the anterior three being shorter than the others, and gradually increasing in length to the fourth, which is about 0·75 in. long. I can discern no ornamentation upon any of these fin rays, which appear to be quite smooth, and become divided into broad quadrate joints in their distal moieties.

The remains of a large interspinous bone are seen at the base of the dorsal fin rays, and supporting them.

The fin rays of the second dorsal have disappeared, but I believe I can perceive indications of its interspinous bone.

The caudal fin (*C*) is very imperfect; the anal and pectoral fins are absent; but the right ventral (*V*) is seen in place, a little behind the level of the anterior dorsal. It is a considerable fin, as large as the anterior dorsal itself.

The scales of this fish are thin, flat, cycloidal, and 0·15 to 0·2 in. in diameter. The middle of the posterior margin of many of the scales (figs. 3 and 4) is produced, so that the exposed portion is nearly triangular. The sculpture consists of raised, continuous, ridges, which converge towards the middle line.

The pectoral arches are strong and broad, and have somewhat spatulate upper ends; they exhibit no sculpture.

Some points in the structure of the skull are so well displayed in this specimen that I have given an enlarged view of it in fig. 2.

The posterior moiety of the roof of the skull (*A*) meets the anterior at an obtuse angle, and exhibits no trace of sutures. The outer surface of this, apparently single, bony shield is ornamented with minute oval tubercles of enamel, which, posteriorly, run together into short ridges. Very little of the anterior moiety of the roof of the skull is preserved, but so much as remains shows a similar ornamentation.

The right operculum (*Op.*) is broad and triangular; its surface is marked by ridges, which take a radiating course from its anterior superior angle. These ridges are rather more interrupted, and as it were tuberculated, than they are shown to be in the figure.

Between the dislocated operculum and the suspensorial apparatus for the lower jaw, several ossified branchial arches (*Br.*) are visible.

The suspensorium itself consists of a closely united hyomandibular (*H.M.*) and palatoquadrate (*P. Qu.*) portion. The latter is a triangular strong plate of bone, and its downwardly and backwardly directed apex ends in a stout condyle for articulation with the mandible. Its upper edge is sharp and free, and its anterior thinner angle becomes connected with the skull, but, in what manner, the state of the specimen does not enable me to say.

The hyomandibular portion of the suspensorium is, inferiorly, covered by the palatoquadrate, but above, it appears, to be stout and prismatic. External to the anterior two-thirds of the outer edge of the palatoquadrate, what appear to be the remains of a maxilla are visible.

Emerging from beneath the anterior attachment of the palatoquadrate, there is a small process of bone which enlarges at its free end (*d*). A similar process, apparently developed from the prefrontal, is seen in *Macropoma* and *Undina*. In front of this, obscure traces of one or two sharp pointed teeth are visible.

The impressions of the right ramus of the lower jaw, and of one of the displaced jugular plates (*G*) are to be seen below the head.

This instructive specimen (like the others, unless the contrary be stated,) was obtained from the Coal measures of Pendleton by Mr. Molyneux, and is now in the Museum of Practical Geology.

No. 2. The specimen represented in Pl. III., figs. 1., 1*a*., 1*b*.

This is a figure, magnified to twice the natural size, of a small *Cœlacanthus lepturus*, not more than three and a half inches long, and so disposed as to display the unusually perfect caudal extremity very well.

The skull is about 0·7 in. long; and, posteriorly, where it is much crushed, it has about half that width.

It is seen from below, and the interspace between the rami of the mandible (*a*, *a*) is occupied by the two broad and elongated

jugular plates (*G*). The surface of each of these bones exhibits a very peculiar ornamentation, consisting of delicate undulating ridges, which, on the whole, run more or less parallel with the outer edges of the jugular plate, but, in front, converge towards its inner edge. The peculiar form and sculpture of the rami of the mandible, are better displayed by other specimens. In front of their symphysis there is a confused mass, doubtless formed chiefly by the premaxillæ, and which exhibits indications of small teeth.

The broad ends of the pectoral arches are displayed at *b*; but the pectoral fins are not visible.

The large, obtusely lobate, ventral is well shown at *V*. It has, at present, fourteen fin rays, which gradually increase in length on either side towards the middle four, which are about equal. These rays present no sculpture, but the broad jointing of their distal halves is very well displayed.

The remains of the dorsal fin appear at *D*.

The caudal fin has about ten fin rays above and below, which are connected with the neural spines by interspinous bones. The rays are jointed in their distal moieties; and the hindermost ones are shorter than the others, and lie more nearly parallel with the axis of the body. The latter narrows rapidly from the commencement of the caudal fin, and continues scaly to its truncated and evidently broken extremity.

The scales *a*, fig. 1*a*, have the same form and sculpture as in the preceding specimen. Fig. 1*b*. exhibits a magnified view of the ornamentation of part of one of the jugular plates.

No. 3. *The specimen represented in Pl. III., fig.* 2.

The chief interest of this specimen (figured of twice the natural size) arises from its showing at *b* the crushed walls of the ossified air bladder, and, at *a*, what appears to be the interspinous bone of the posterior dorsal fin. Its crura diverge at a somewhat more open angle than that shown in the figure. The anterior dorsal fin (*D*) of this specimen is unusually long.

No. 4. *The specimen represented in Pl. III., figs.* 3, 3*a*, *and Pl. IV., figs.* 1 *and* 2.

Of these figures the first is of the natural size; the two others are magnified, and fig. 2, Plate IV., has been accidentally inverted. They are taken from the two counterparts of a split specimen, and throw much light upon the structure of the mandible, the jugular plates, and the branchial apparatus.

Each ramus of the mandible (*Mn*), when viewed laterally, as in fig. 2, Plate IV. (which represents the right ramus) presents a nearly straight lower margin, while the upper edge is sinuous; the upper contour of the ramus attaining its greatest height rather behind its centre, and thence rapidly descending forwards and backwards. In the horizontal plane, the hinder part of each ramus is nearly straight, but its anterior end curves sharply inwards towards that of its fellow (Plate IV., fig. 1), to the symphysis.

The outer surface has an ornamentation composed of minute ridges of enamel, the ridges having a direction generally parallel with the axis of the ramus.

In the elongated oval jugular plate (*G*) of this specimen (Plate IV., fig. 1.), the ridges of the ornamentation are more completely transverse to the axis of the plate than in the specimen No. 3 (Plate III., fig. 2).

The impressions of five strong bony branchial arches are plainly visible on the left side. Minute horny, or osseous, filaments seem to have been set at right angles to the branchial arches along their edges (Plate IV., fig. 1).

Connecting the branchial arches is a strong median ossification, consisting of an anterior cruciform part, and a posterior elongated spatulate portion. The two anterior branchial arches are connected, the one with the outer end, and the other with the base, of a tranverse arm of the cross; the three other arches unite with the sides of the posterior division, while the long spatulate end lies free between the hindermost pair of arches (Plate IV., fig. 1). Fig 3*a*. represents a scale of this specimen magnified.

No. 5. *The specimen represented in Pl. IV., fig.* 3.

The under surface of a crushed head of *Cœlacanthus lepturus*, showing the ornamentation of the jugular plates. In the collection of Edw. Binney, Esq. F.R.S.

No. 6. *The specimen represented in Pl. IV., figs.* 4 *and* 5.

These fragments, figured of the natural size, show, in fig. 4, the elongated pelvic bones still connected with a part of the ventral fins; and, in fig. 5, the anterior (*D*) and posterior (D^1) dorsal fins, apparently but little displaced from their normal position.

No. 8. *The specimen represented in Pl. IV., fig.* 6.

A very perfect hinder moiety of a *Cœlacanthus*, somewhat larger than any of the foregoing, drawn 1½ times the size of nature.

The persistent notochordal space, with the superior and inferior bony arches and spines, the interspinous bones, and the fin rays, are very clearly displayed. There seem to be 12, or perhaps 13, fin-rays in each lobe of the caudal fin; and, as in No. 2, the posterior fin-rays lie nearly parallel with the axis of the body. The jointing of the broad distal portion of these rays in very distinct. The scaly central part of the body (C^1) passes backwards into a prolongation about 0·1 in. wide, also covered with small scales, and beset along its upper and lower margins with small fin-rays, which appear to be simple and unjointed.

Cœlacanthus lepturus attained considerable dimensions. A specimen obtained by Mr. Molyneux from the Ladies Well Colliery,

Cheadle, North Staffordshire, shows that the parieto-occipital region of the head was at least 1·5 in. long, and that the length of the whole head could not have been less than 3¼ inches. The entire fish, therefore, was probably not less than 12 to 14 inches in length.

In this large specimen the surface of the parieto-occipital region, and of so much of the frontal region of the skull as is preserved, as well as that of the opercula, are covered with oval tubercles of enamel, set so closely as to leave no interspace. On the parieto occipital shield these tubercles are about $\frac{1}{50}$ of an inch long, but on the opercula and the fragments of the external facial bones they become both actually and proportionally longer. The left pectoral fin is about an inch and a half long, and has a distinct, though small, scaly lobe. The ornamentation of the scales is quite as in the smaller specimens, but the scales are fully 0·3 in. in diameter.

II. Cœlacanthus elegans, Newberry.

I am indebted to Sir Philip Egerton, Bart., for the opportunity of studying several specimens of the *Cœlacanthus elegans* of Dr. Newberry, from Liston, Ohio, and I figure three of them for comparison with *Cœlacanthus lepturus*.

No 1. *The specimen represented in Pl. V., fig.* 1.

The caudal extremity of this specimen is broken off, but its extreme length, when entire, could hardly have exceeded 5·75 in. The length of the head is 1·3 in., so that the whole body was between four and five times as long as the head.

The fish is crushed in such a manner as to have its depth unnaturally increased, and the right ventral fin is seen to be detached, and lies below the left. From the line of the back at the front boundary of the first dorsal fin, to the opposite point of the belly is 1·4 in.

The scales, in a tolerably good state of preservation, are about 0·15 in. in diameter, thin and flat, and would be circular were not their posterior margins produced into an obtuse point (Plate V., fig. 3).

Each scale is ornamented with narrow, wavy, nearly parallel ridges, which converge towards and meet along, a line drawn through the centre and the point of the scale. I observe no marked differences among the scales of different parts of the body, nor any trace of a lateral line.

The neural arches have the ordinary form, and are close set. A series of subvertebral arches correspond with them in the caudal region, but there is no more trace of ribs in this species than in *C. lepturus*.

Fourteen or fifteen fin rays, jointed in their distal portions, are discernible in the anterior dorsal fin (D), and seven or eight in the posterior (D^1), the anterior edge of which is opposite the most

anterior subvertebral bones. A large single interspinous bone supports the anterior dorsal fin, but the interspinous bone of the second dorsal is concealed.

The anal fin (*A*) is but obscurely indicated, but lies rather in front of the anterior margin of the second dorsal. The left ventral fin is in place, and is situated as in *C. lepturus*. The strong and broad bones of the pectoral arch are devoid of sculpture externally, and in form resemble those of *C. lepturus*.

The upper contours of the anterior and posterior regions of the skull do not pass evenly into one another, but meet at an obtuse angle. The operculum is large, extending from the roof of the skull to near the angle of the jaw, and has the form of a triangle with the base upwards. It is ornamented with fine ridges, which, on the whole, radiate from its anterior superior angle. The structure of the skull in front of the operculum cannot be deciphered.

The mandible is in place, though a good deal broken. So much of its outer surface as is preserved exhibits the characteristic sculpture.

Minute conical teeth are visible at the anterior end of the snout, and there is one in the palatine region, but these teeth are detached, and but obscurely visible.

No. 2. *The specimen represented in Pl. V., fig.* 2.

In this example the tail, with the anal (*A*) and second dorsal (D^1) fins, are well displayed. Twelve fin rays, having the same arrangement as in *C. lepturus*, can be counted above and below, and there is a medial scaly caudal prolongation, which, however, is not sufficiently preserved to show the small fin rays which it doubtless possessed.

No. 3. *The specimen represented in Pl. V., fig.* 4.

A much crushed head, showing the jugular plates and scales of *Cœlacanthus elegans*, and exhibiting three, or perhaps four, sharply pointed conical teeth, connected to all appearance with the premaxilla. The largest of these teeth is not more than 0·05 in. long. The ornamentation of the jugular plates is like that in *C. lepturus*.

III. Cœlacanthus caudalis, Egerton (Plate V., fig. 5).

Sir Philip Egerton's excellent account of this species has already been quoted at length, and I describe and figure the type specimen anew, merely for the purpose of comparing it with the Cœlacanths already described, and of using it to supplement the information derived from them.

In fact, although the head of this specimen is much crushed, the extreme end of the tail is absent, and the scales are wanting, the skeleton of the trunk and fins has left the mark of its parts in almost undisturbed relation to one another.

The animal is a little bent up towards the dorsal side. Its length, measured in a straight line, is 4·7 in.; the head is 1·1 in. long, or, as in *C. elegans*, rather more than one-fifth the whole body. The front edge of the anterior dorsal fin (*D*) is distant 1·85 in. from the end of the snout, and the base of this fin is 0·25 in. long. From the front edge of the first dorsal to that of the second (D^1) is a distance of 0·95 in.; the base of the second is 0·2 in. long. The front edge of the upper lobe of the caudal fin (*C*) is 0·7 in. from the front edge of the second dorsal, and 3·6 in. from the end of the snout. Only the right pectoral fin, detached from the pectoral arch and thrown backward, is visible. The two ventrals (*V*) close together, and opposite the level of the posterior margin of the anterior dorsal, are apparently in, or close to, their natural position; they are distant 2·35 in. from the snout.

The small anal (*A*) is opposite the second dorsal, and 3·15 in. from the snout.

The greatest depth of the fish, 0·95 in., is opposite the first dorsal fin.

The pectoral fin (*P*) is rather more than 0·5 in. long, and 0·2 in. broad at its base; it is obtusely lobate, and contains, at fewest, 18 fin-rays. The foremost of these rays are unjointed through the greater part of their length.

The ventral fin (*V*) is 0·6 in. long and about 0·2 in. broad, or of nearly the same size as the pectoral. It is obtusely lobate, and 17 or 18 fin-rays may be counted in it. As in the pectoral fin, the foremost of these fin-rays are shorter than the others, and remain undivided through a great part of their length.

An impression of one, or both, of the pelvic bones (*Pv*) lies in front of the ventral fins, but apparently out of its normal position, as its base is in advance of these fins.

The anal fin (*A*) is somewhat bent upwards and backwards out of its natural position. What there is of it has a length of 0·4 in., a breadth at the base of 0·15 in. Fifteen or sixteen fin-rays may be counted, and they appear to be similar in structure to those of the pectoral and ventral fins. There is no evidence that this fin was lobate.

The base of the inferior lobe of the caudal fin (*C*) is 0·75 in. long, and exhibits 14 fin-rays, the hindermost of which are nearly parallel with the axis of the body, and probably indicate the natural termination of the fin. The anterior are shorter than the posterior fin-rays, and, so far as they are preserved, none of the fin-rays exhibit distinct joints.

The upper lobe of the caudal fin resembles the lower, and begins opposite to, or perhaps a little in advance of it.

The interspinous bones appear to correspond in number to the fin-rays, (unless there may be one or two in front which have no fin-rays,) and to be broader at each end than in the middle. Opposite the anterior end of the caudal fin, the whole depth of the body is about 0·65 in., and is divided into five nearly equal areæ by the impression of the notochord in the middle and those of the vertebral arches and interspinous bones, above and below.

The second dorsal fin (D^1) contains 14 rays; its basal breadth is 0·2 in., its length not less than 0·5 in. The rays are slender, and only become jointed towards their extremities. The peculiar forked interspinous bone of this fin is not in its place, but I believe I can trace indications of it in the space between the lower edge of the first dorsal and the ends of the neural arches.

The first dorsal (D) is fully 0·8 in. long and 0·25 in. broad at the base; 11 or 12 fin rays can be counted, which are much stronger than those of the other fins, and, like the others, are only jointed at their tapering distal ends. I observe no spine-like tubercles upon these, any more than upon the other, fin-rays. The impression of the broad interspinous bone of this fin is plainly visible *in situ*.

About 23 close-set superior, or neural, ossified arches, occupying about 0·5 in., may be counted immediately behind the head. The spinal column is there interrupted for nearly the same distance, and a solitary neural arch is seen thrown down out of the series. Behind this point the neural arches are undisturbed, and opposite them, on the ventral side of the body, the series of subvertebral arches commences. That the point at which these commence is, in fact, part of the caudal region is shown by its relation to the position of the ventral fins. More than 40 neural arches can be counted behind the break, and there were therefore probably not fewer than 80 in the whole series. The number of subvertebral arches cannot be satisfactorily ascertained. There are no ribs in the dorsal region.

I am inclined to think that a distorted and V-shaped elevation which occupies the portion of the cavity of the body immediately under the anterior dorsal fin, is the remains of the ossified air bladder.

The head is so crushed that nothing definite can be made of its structure. The strong pectoral arches are discernible immediately behind it, but they also are much crushed.

No sculpture is visible upon what remains of the cranial bones.

IV. Cœlacanthus elongatus, Huxley.

The specimens to which I have applied this name, rather because I cannot identify them with any other species than because they have good positive characters of their own, are all mere impressions in shale, from Ballyhedy, near Ballinhassig, county of Cork, Ireland. They were sent to me by my colleague, Professor Jukes, the local director of the Geological Survey of Ireland, and are now in the collection of that Survey.

No. 1. *The specimen represented in Pl. V., fig.* 6.

This fish was probably about 3·5 in. long when entire. The head is somewhat less than one inch long, and appears more elongated and tapering in proportion than in the other species.

The anterior edge of the dorsal fin is 0·65 in. from the head,

and is thus further back in proportion; the depth of the body at this point is 0·5 in.

The cranial impression is marked by deep and irregularly disposed lines, the correspondence of which with the probable outline of the cranial and facial bones is not apparent. Besides and between these markings the impression of the skull presents traces of a minutely granular, or lineated, sculpture.

The anterior dorsal fin (*D*) is 0·5 in. long, but only eight or nine of its fin rays are preserved, and there is no trace of the interspinous bone. There is an interval of 0·7 in. between the bases of the anterior and posterior dorsal fins, and the latter (D^1) exhibits 13 or 14 long fin rays, with one or two short ones in front; the whole fin is 0·4 in. long.

The impressions of both bones of the pectoral arch are discernible, and the confused fin rays of apparently both pectoral fins (*P*). Each fin was about 1·5 in. long. About 37 neural arches may be counted, those nearest the head being smallest. There are no dorso-abdominal ribs, and the subventral bones begin nearly opposite the 25th neural arch. No ventral fins, nor any part of the caudal, are visible, in consequence of the breaking away of the matrix in their region.

No. 2. The specimen represented in Pl. V., fig. 7.

This is very like the preceding, but in some respects it is more complete. The extreme length is 3·6 in. The length of the head is about 0·85 in., unless the anterior end of the snout is absent. The head presents longitudinal and oblique groovings similar in their general character to those of the foregoing example: and, as in the latter, there is a rounded depression, like an orbit, situated at the junction of the posterior and the anterior three-fourths of the length of the head. Here and there, indications of a granular and lineated sculpture are visible. The impressions of the bones of the pectoral arch are well seen; they appear not to have been so rounded and expanded above as in the other Cœlacanths.

Twenty-five dorsal abdominal neural arches, unaccompanied by ribs, can be counted (there were probably several more) before the series of subvertebral bones begin, on the under side of the space occupied by the notochord.

The front edge of the anterior dorsal fin (*D*) is 0·6 in. from the posterior end of the head. At least ten rays can be counted in it, but its distal end being hidden under matrix, its precise length cannot be ascertained. An interval of 0·6 in. separates the bases of the two dorsals, and so much of the second (D^1) as is visible, shows it to have been, as in the preceding specimen, stouter than the first dorsal. Thirty-seven neural arches can be counted in front of the point of commencement of the upper lobe of the caudal fin (*C*), the impression of which shows it to have had the ordinary Cœlacanth structure. The anal and ventral fins are not visible. Both pectorals (*P*) are seen, the right nearly in place. Its rays are very delicate and nearly 0·7 in. long if traced to their extreme ends. No trace of the pelvic bones, or interspinous bones, is visible.

This Cœlacanth appears to have attained much larger dimensions, as a fragmentary specimen from the same locality has neural arches 0·45 in. long, whilst those of the example described nowhere reach 0·2 inches.

A fragment of a caudal extremity of a Cœlacanth, in the same collection, leads me to suspect that a second, deeper and shorter bodied, species may have coexisted with this.

Numerous specimens sent to me by Prof. Jukes demonstrate the existence of a true *Cœlacanthus* in the Coal measures of Ballybunnion, Kerry. The largest impressions belong to fish about 12 inches long, and the fossils vary from this size to less than six inches. In none are the scales or the form of the head preserved, and hence I can give no strong opinion as to the specific distinctness of this Cœlacanth, or its identity with other species. I am inclined to think, however, that it is rather more slender than *C. lepturus*.

The Genus *HOLOPHAGUS*, Egerton.

The unique specimen upon which this genus is based is thus described by Sir Philip Egerton in a note at page 19 of the "Preliminary Essay" of the tenth Decade:—

Holophagus Gulo.

"Mr. Harrison's specimen wants the anterior portion from the dorsal and pectoral fins forwards. From the insertion of the dorsal fin to the extremity of the tail it measures 11½ inches, and 4½ inches in depth. The stomach is distended with a recently swallowed Dapedius, and a large coprolite occupies the rectum. The first dorsal fin springs (as in *Macropoma*) from a single disc, resulting from the coalescence of the interneural spines. It contains eight long, thick, undivided, and multiarticulate rays. They are beset with numerous short spines or tubercles. The second dorsal is situated 4 inches behind the first. Between the two is seen a strong bifurcate interneural ossicle, which has been displaced forwards from its proper position at the base of the fin. The second dorsal fin contains sixteen rays. The anterior ones are short and slender. The succeeding ones are long, broad, and multiarticulate, but not tuberculate. The base of the fin is obtusely lobate, with a scaly investment. The pectoral fins are much mutilated. Judging from what remains of them, and from some indistinct impressions, they seem to have been of great size. The anal fin occurs immediately below the second dorsal fin, with which it corresponds in form and structure, but contains many more rays. The ventral fins are mutilated, but their position below the first dorsal fin is indicated by the preservation of a pair of strong T-shaped pelvic bones, having their longer limbs directed forwards, and nearly reaching the base of the pectoral fins. The caudal fin is of great size, and presents in an eminent degree the most special and characteristic feature of the Cœlacanthus family, namely, the interposition, in the caudal region, of an interneural between the neural and dermoneural spines. The base of this spine abuts upon the extremity of the neural spine, and unites with the true fin ray by an overlap or splice. This structure coincides with that observed in *Undina*. In *Macropoma* the bone of the interneural spine is bifurcate for the reception of the distal extremity of the neurapophysis. A small supplemental fin extends an inch beyond the larger caudal fin, as in *Undina* and *Cœlacanthus*. The notochord is unossified. The apophyses, both above and below, have very wide bases. The scales are curvilinear, and covered with a vermiculate pattern on the upper surface, occasionally broken up into small tubercles."

The specimen referred to in the foregoing description is in the Museum of Practical Geology, and is figured, one-half the size of nature, in Plate VI.; with enlarged views of a scale, of anal and of caudal fin-rays. *D* is the first dorsal fin; D^1, the second dorsal fin; $D^1 1$, its interspinous bone; *A*, the anal fin; *C*, the caudal fin; C^1, the supplemental caudal fin-rays; *Pv*, the pelvic bones.

The Genus *MACROPOMA*, Agassiz.

I. Macropoma Mantellii, Agassiz (Plates VII. and VIII.)

Attention was first directed to this remarkable genus of Cœlacanth fishes, in 1822, by the late Dr. Mantell, who, at page 239 of his work "The Fossils of the South Downs," gives the following account of the specimens which had fallen under his observation:—

Amia? Lewesiensis. Tab. xxxvii., xxxviii.

"The length of this ichthyolite generally exceeds 18 inches, the head being equal to one-third of the whole; the width is about 4·5 inches. The body is of an elongated form, slightly compressed, scaly and reticulated.

The scales are of a rhomboidal shape, and beset with numerous small adpressed spines, producing a scabrous reticulated appearance, not unlike the surface of some kinds of *Balistes*. The head is angulated; the orbit large; the opercula smooth and rounded; the jaw dentated and nearly straight. The teeth in the upper maxilla are conical, pointed, and rather flat; there are about 40 on each side, of which the eight or nine anterior ones are the largest. Those of the lower jaw are exceedingly small and very numerous. The dorsal fins are two in number; the anterior one (*a*, Tab. xxxvii.) is placed in a sulcus or groove in the back, and appears to have been capable of erection or depression; it consists of eight strong rays, the two first being garnished with spines. The posterior dorsal fin (*b*, Tab. xxxvii.) is remote from the other, and composed of numerous delicate rays. The pectoral fins are placed on the thorax, near the lower margin of the opercula. The ventral fins (*c*, Tab. xxxvii.) are attached to the abdomen opposite to the anterior dorsal fin. The anal fin is unknown. The tail appears to have been rounded, but no perfect specimen of this part has been obtained. The tongue is occasionally preserved (*vide* Tab. xxix., fig. 6; Tab. xxxiv., fig. 7.) It is of a triangular form, and its surface is covered with numerous papillæ. The air bladder is of an elongated oval shape, and lies in the abdomen immediately beneath the spine." *

Dr. Mantell compares the fish with *Mugil*, *Balistes* and the *Amia ignota* of De Blainville.

In the third chapter of the second part of the second volume of the "Recherches," Agassiz established the genus *Macropoma* for the fishes discovered by Mantell; and he describes the characters of the new genus and discusses its relations in the following terms:—

"It is incontestable that this genus has striking affinities with the genus *Cœlacanthus*. The body is similarly thick, and the fins have a like arrangement. There are, as in *Cœlacanthus*, two dorsal fins, one of which lies opposite the interval between the pectorals and the ventrals, and the other opposite the space between the ventrals and the anal. The second dorsal is supported by a very strong bone, which is also found in many other genera of the family. The caudal is largely

* "It may seem scarcely credible that a part of such delicate structure should be preserved in a mineralized state, yet the fact is unquestionable. I have three specimens in my collection in which it is clearly shown."

developed, and greatly surpasses all the other fins. The scales also present a certain resemblance to those of *Cœlacanthus*, in size as well as in form. But, on the other hand, the structure of the rays is very different; their cutting edges are beset with spines, and they doubtless served as protective weapons to the animal, while those of the *Cœlacanthus* are smooth. The skeleton is strong, but I have not been able to satisfy myself whether the bones are hollow or not."

MACROPOMA MANTELLII, Agass.

" . . . . . The head is very large; it equals more than one-fourth of the length of the body; its bones are strong, and their surface is finely dotted. In the specimen figured in Plate 65 a, the roof of the cranium, the bones which surround the orbit, the jaws, a part of the opercular apparatus, the branchial arches, and a part of the thoracic girdle are readily distinguishable in their natural relations.

" The lower jaw has a very irregular outline; its dentary edge is grooved in front, and descends towards its articulation with the os quadratum. The pterygopalatine arch is very wide, especially behind. It is the palatines and the vomer which carry the largest teeth. On the other hand, the superior maxillary, which forms the edge of the upper jaw, has none.

" The fore part of the head [*front*] is concave, and rises as a rounded projection above the orbit. The posterior suborbitar is a large osseous plate, granular on its surface like the cranium: the anterior suborbitars are elongated. The operculum has its posterior edge rounded. The branchial arches are very large and strong, whilst the thoracic girdle is proportionably weak. As in the pike, this arrangement is doubtless calculated to facilitate the deglutition of a large prey.

" The scales are large, and envelope the whole body in a thick cuirass, which appears to extend very far on to the caudal, judging by the impressions observable upon the lower lobe of the tail. The surface of all the scales is granulated, and this granulation is so persistent as to be recognizable when the scale is much worn. I have represented in Plate 65 b, fig. 1, a portion of the body of a fish which I believe to be the young of the same species, and whose scales are in so perfect a state of preservation that their minute structure may be studied in detail. They have for the most part a rhomboidal form, at least they appear thus when superposed (as in nature). Isolated they present a very different form, when the root of the scale is preserved, as in fig. 3, Plate 65 b. Examined with a lens it is seen that the superficial rugosities are produced by a quantity of little elongated tubercles, or rather of small pointed cylinders, which cover all the visible part of the scales. The largest and longest are in the middle of the scale; those at the sides are shorter and more slender: the covered part of the scale is completely deprived of them; it is smooth, and exhibits only the lines of growth (Plate 65 b, fig. 3). For the rest there is no very marked difference among the scales of different parts of the body. . . . . I have not succeeded in discovering any trace of the lateral line; doubtless the superficial tubercles prevent the mucous canals from being recognized.

" The fins present peculiarities no less singular than those of the scales. All the rays are stiff and very stout: they do not dichotomize, and are not jointed: but on each side they are beset with a series of strong spines, turned towards the extremity of the ray. Their bases are divided into two branches, so as to form a cleft which embraces the apex of the interspinous bone. At least,

the dorsal fin rays are constructed in this manner . . . . . There are two dorsal fins; the first is situated immediately behind the pectoral girdle; its rays are long and very strong. The second, situated opposite [*en face*] the anal (Pl. 65 a), has rays which are less robust, shorter, and more numerous, borne by a great bifurcated interspinous bone. In this specimen the fin has not fewer than 13 rays. The ventrals and the anal are nearly of equal size; the ventrals are opposite the middle of the space comprised between the two dorsals; the anal is rather further back than the second dorsal. Both are composed of very short, but strong rays.

"The caudal is extremely broad, and if, as everything seems to show, it is entire in the specimen (Pl. 65 a), it offers a most curious type of structure, a kind of great fan, all of whose rays appear to be equal. It is probable that it was rounded, as in certain Sauroids, at least no difference is observable between the upper and the lower rays. This fin is, in addition, supported in equal proportions by the superior and inferior caudal spinous processes, and the vertebral column is nowise bent upwards, as is the case in all the inæquilobed Ganoids. Its rays are very strong. I have counted some twenty in the lower, and a few more in the upper lobe. All are nearly equal, and only the anterior ones, situated at the base of the fin, are a little shorter. Their structure is the same as in the other fins, that is to say, the visible part of the ray is supported by a shorter ray, which is itself supported by the spinous processes of the vertebræ. The greater part of the caudal vertebræ thus afford support to the caudal fin, and it is this which gives the fin its great width.

"The internal skeleton of our *M. Mantelli* is in general robust. The apophyses are short but large, at least in the neighbourhood of the tail; those of the abdominal vertebræ are longer, and bent more backward. The vertebræ, on the other hand, are small and delicate relatively to the size of the fish.

"But our knowledge of this remarkable fish is not limited to the skeleton; many of the soft parts are also preserved. Among others, there are, in Mr. Mantell's collection, many specimens of the trunk in which the stomach is distinctly recognizable. (Pl. 65 c, fig. 1, and Pl. 65 d, fig. 1.) It resembles a squamose cylinder, an appearance which is evidently the result of the changes which have taken place in the different membranes which compose its walls; vascular trunks can even be perceived. These remains are commonly accompanied by coprolites, which have evidently been formed in the intestine. They have a general resemblance to those of Sauria, and are sometimes grooved in the same way. I have represented a series of them in Plate 65 a, to show the variety of forms which they affect. It is these coprolites which have been described by many authors as petrified fircones." (P. 177.)

In the explanatory notes which follow Prof. Agassiz speaks of the "bassin," without describing it, and of the "plaque qui tient lieu de rayons branchiostègues."

When Professor Agassiz published his "Monographie des Poissons Fossiles du Vieux Grès Rouge," his views respecting the systematic position of *Macropoma* appear to have undergone considerable change. Thus he observes, at p. 61;—

"J'ai déjà fait remarquer que le genre *Macropoma* de la craie, ainsi que le genre *Undina* de M. le Comte de Münster, cadrent mal avec les

autres Célacanthes . . . . . C'est dans l'Old Red et dans l'houille que la famille des Célacanthes acquiert son plus haut degré de développement ; passé cette epoque elle décline rapidement, et son dernier représentant, qui d'ailleurs est fort douteux, appartient à la craie."

In 1849 Professor W. C. Williamson gave an account of the structure of the scales and the walls of the ossified air bladder of *Macropoma* in his valuable memoir "On the Microscopic Structure of the Scales and Dermal Teeth of some Ganoid and Placoid Fishes," published in the Philosophical Transactions for that year.

Professor Williamson shows that the tubercles which ornament the scales and opercular plates of *Macropoma* are composed of layers of kosmine coated with ganoin, and resting, in the case of the operculum, upon lamellæ of bone, in that of the scales, upon a lamellar substance which contains no lacunæ, but presents layers of irregular tubes interposed between the lamellæ. Successive layers of the tubes cross one another in direction.

At the base of each tubercle, whether on the operculum, or on the scale, there is a cavity, which communicates by one or more canals with the exterior.

The walls of the structure called "air bladder" by Mantell* (who seems to have considered the solidity of the parietes of this organ to result from mineralization) and "stomach" by Agassiz, are proved by Professor Williamson to be composed of lamellæ between which are developed large lacunæ, identical with those found in the endoskeleton of the fish. Some of the external lamellæ lose their exact parallelism with those below, and one in particular assumes an undulating arrangement. On both sides of the folds of its undulations large irregular lacunæ are placed. This again is invested by other dense and apparently structureless lamellæ, which fill up the inequalities of the undulating layer, and form the external smooth surface of the organ.

With respect to the functions of this apparatus, Professor Williamson remarks:—

"I am disposed to believe that it has been an organ fulfilling the functions of an air bladder. Its osseous structure would render it capable of resisting a considerable amount of pressure ; and if its patu-

* In the Medals of Creation, 1844, Mantell gives up his first interpretation, and adopts that of Agassiz, but in "The Petrefactions and their Teachings," 1851, p. 437 he writes :—"*Air Bladder (or Stomach?) of the Macropoma.*—In every example of "this fossil fish that I have dissected, there lies within the body, generally nearest the "upper or dorsal part of the cavity, a long hollow cylindrical substance, often "7 inches in length, and 1½ inches in diameter, covered with a thin, brittle, scaly integu-"ment, which readily separates into two or three laminæ. The anterior part of this "organ, which lies close to the posterior margin of the opercular bone, is always "imperfect, appearing as if torn or ruptured ; the caudal extremity terminates in a "*cul-de-sac*. From the situation and structure of this viscus I supposed it to be an "air bladder, and described it as such in the "Fossils of the South Downs," in 1822, "but on Professor Agassiz's visit to my museum at Brighton, that eminent naturalist "pronounced it to be the stomach. Recent microscopic investigations of the invest-"ing integument have, however, tended to establish the correctness of my original "interpretation of the nature of this remarkable body."

lous extremity has been closed up by an elastic membranous appendage capable of acting as a valve, this would enable the creature to regulate its buoyancy, by increasing or diminishing the compression of the contained air, and thus facilitate its movements in either shallow water or at great depths. Except in cases of diseased ossification, the existence of an internal thoracic or abdominal viscus having hard parietes of true bone, is an anomaly which, as far as I am aware, has hitherto presented no parallel in nature."

Professor Williamson finally remarks that the structure of—

"The scale of *Macropoma*, as now described, is wholly different from that presented by any of the ganoid fish noticed in the preceding pages [*Lepidosteus*, *Lepidotus*, *Semionotus*, *Pholidotus*, *Ptycholepis*, *Dapedius*, *Palæoniscus*, *Gyrodus*, *Aspidorhynchus*, *Accipenser*, *Platysomus*, *Megalichthys*, *Diplopterus*, *Holoptychius**]. It bears a much closer resemblance in its leading points to the dermal appendages found amongst the group of true Placoids, between which and the Ganoids *Macropoma* appears to form an inosculating link." (L.c. p. 464.)

In 1857, Sir Philip Egerton described and figured the specimen named *Macropoma Egertoni* by Agassiz, in the ninth of our "Decades," Pl. 10. This fossil, which was obtained from the Gault of Speeton, Yorkshire, exhibits only the anterior half of the fish, comprising the head, the pectoral fin, and the first few rays of the dorsal fin.

"The inclination of the profile line of the head is very steep from the occiput to the orbit, far more so than in the allied species; the orbit is situated in a more advanced position, and the facial line thence to the snout falls much more rapidly. The orbit in this species is large, and a portion of the capsule of the eye is preserved. The frontal bones are wide, coarse in texture, and bear a few scattered granules on their exterior surface. The borders of the upper jaw are formed of the superior maxillary bones, which are very broad; they are beset with very numerous sharp-pointed teeth, closely arranged, and of uniform size. The lower jaws are also very broad, and the space between the rami is closed by a single glossohyal plate, as in *Lophiostomus*, *Arapaima*, and *Amia*."

As regards the scales, Sir Philip Egerton remarks that—

"The surface ornament is very different; instead of the distinct tubercles so characteristic of that species (*M. Mantellii*); it is composed of minute granules united into longitudinal rows, with only a few small tubercles interspersed occasionally on some of the larger scales."

I venture to doubt that this fish belongs to the genus *Macropoma*, for the following reasons:

1°. The upper contour of the skull is quite unlike that which is seen in *Macropoma* and appears to be characteristic of the Cœlacanths in general.

2°. In no *Macropoma*, and in no Cœlacanth, however well preserved, have I seen any trace of an ossified capsule of the eyeball.

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* This is not the true *Holoptychius* of the Old Red, but a distinct genus, *Rhizodopsis*.

3°. The jugular [glossohyal] plates of *Macropoma*, as of all Cœlacanths, are double and not single.

4°. The shape of the lower jaw is quite different from that which is so characteristic of the same part in *Macropoma*, and the maxilla and other bones of the face are very different.

5°. The figure clearly displays several strong osseous ribs, while neither in *Macropoma*, nor in any other Cœlacanth, have such ribs been observed.

6°. The pectoral fin, judging by the disposition of its fin rays, does not seem to have been lobate, and the fin rays themselves appear to be articulated throughout, and not entire at their proximal ends, as in *Macropoma*.

I conceive the evidence adduced to be sufficient to prove that "*Macropoma*" *Egertoni* is not a "*Macropoma*," and indeed not a Cœlacanth at all. I therefore propose the generic name of *Eurypoma* (suggested to me by Sir Philip Egerton) for the fish, retaining the specific title of *Egertoni*.

In a note appended to the description of this fish, Sir Philip Egerton states that he has received from Mr. Beckles "a specimen of a "*Macropoma* found in the quarries of Purbeck stone near Swan-"age. The specimen is not sufficiently perfect to determine the "species; it seems to be a shorter and deeper fish than *Macropoma* "*Mantellii*." I presume that this is the specimen to which Dr. Mantell refers (Wonders of Geology, p. 359).

The passages which I have quoted include, I believe, all the statements of any importance which have been published respecting the organization of *Macropoma Mantellii*. I propose to supplement the information which they contain by the following remarks upon the structure of the skeleton of this fish.

The Spinal Column.—This is as completely devoid of ossified vertebral centra as in other Cœlacanths, and its structure exactly corresponds with that of the corresponding region in them (Plate VII., fig. 1).

The neural arches and spines are continuously ossified, and the former embraced the persistent notochord as in a fork. There are no bony ribs,* but the tail is provided with subvertebral bones, which closely resemble the neural arches and spines.

The Median Fins.—No specimen which I have met with shows a terminal prolongation with small fin-rays, but in other respects the caudal fin is similar to that of *Cœlacanthus* and *Undina*.

The anterior margins of the fin-rays of the median fins present

* The only specimen of *Macropoma* in which I have observed the slightest indication of ribs, is No. 25,782 in the British Museum. In this example four or five elongated bones lie on the left side and partly covered by the walls of the air bladder; but it is impossible to be certain that they may not be displaced neural spines. In *Holophagus* there are impressions of a few short rib-like bones below the posterior part of the dorsal region of the vertebral column.

near their bases a shallow groove, in which series, at first single, of rounded pits appear. In each of these pits a short pointed spine is fixed.

More towards the distal end of the fin-ray the rows of pits and spines become double, those of the two sides usually alternating. In no specimen I have met with does a fin-ray present any indubitable articulation. It is probable that the extreme ends were articulated, but the length of unjointed fin-ray is remarkable in *Macropoma*, as compared with *Holophagus* and *Cœlacanthus*.

The first dorsal fin is supported by the single lamellar interspinous bone (Plate VII., fig. 1), which is as characteristic of the Cœlacanths, as the forked interspinous bone of the second dorsal (Plate VII., fig. 1), indicated by Agassiz. The true form of the first dorsal bone is best exhibited in No. 4,260 of the British Museum, which shows it to be plough-share shaped, the anterior margin being oblique, and much longer than the posterior. Several ridges radiate from its upper edge downwards and forwards to its anterior inferior angle and inferior edge.

The Pectoral and Ventral Fins.—The pectoral fins are supported by a very strong bone, curved so as to be concave forwards, flattened from side to side, and giving off a process upwards and backwards, so as to appear bifurcated above. (Pl. VII., fig. 4 *b*.)

The ventral end of each pectoral arch widens out in a direction transverse to the axis of the body, and becomes concave from side to side behind, so that this part of the bone takes on much the appearance of a marrow spoon. This is particularly well seen in No. 4,251 of the British Museum Collection.

I have met with only one specimen of the chalk *Macropoma* which shows the structure of the pectoral fin distinctly. In this (Coll. British Museum, 4,258) the right pectoral is thrown forward, and seen from the inner side (Plate VII., fig. 5). The rays, about 20 in number, decrease in strength from before backwards, and their inner ends are so arranged as to show that they fringed an obtuse lobe. On this no trace of scales was discernible, but the left pectoral, which is imperfectly preserved, shows the remains of a covering of small scales with a tuberculated ornamentation.

The pelvic bones are very long, and each has, at its base, a strong process directed at right angles to the axis of the bone, and meeting its fellow of the opposite side (Plate VII., fig. 1).

There is a specimen showing a ventral fin in the British Museum (No. 25,944), in which the fin-rays are so disposed as to lead me to believe that it was lobate.

The fin-rays of the paired fins do not seem to have possessed the spinous ornamentation along their anterior edges, which is seen in the median fins.

The Skull.—The roof of the skull (Plates VII., fig. 1, VIII., fig. 2), is divisible in *Macropoma*, as in *Cœlacanthus*, into two moieties, an anterior or frontal (B), and a posterior or occipito-

parietal (A) which meet at an obtuse angle, the occipito-parietal moiety being nearly parallel with the base of the skull, while the frontal slopes obliquely forwards and downwards to the snout; the occipito-parietal portion is slightly convex from before backwards, and more so from side to side; while the frontal portion, though convex from side to side, is slightly concave from before backwards.

Viewed from above, the occipito-parietal shield (A, fig. 2, Pl. VIII.) has a trapezoidal form, being more than twice as wide behind as in front, in consequence of the production of its postero-lateral angles. A median sutural line distinguishes it into two halves; and, in the specimen represented in fig. 1., Pl. VIII., what appears to be a true suture runs obliquely from the median suture outwards and forwards to the outer margin of the parieto-occipital shield, cutting off a large triangular plate of bone, which appears to represent the so-called "*squamosal*" and the *suprascapular* (*S. Sc.*) of ordinary fishes from the proper parietals (*Pa.*)

The sculpture of this part of the roof of the skull presents the form of reticulated ridges and grooves, directed more or less transversely, with interspersed dots and splashes of enamel.

The frontal shield (B, fig. 2, Pl. VIII.), similarly viewed from above, is rounded in front, somewhat constricted in the interorbital region, and truncated behind, where it joins the parietals.

Like the posterior shield, it is divided by a median longitudinal suture, and in the specimen figured in Pl. VIII. it presents indications of the existence of a transverse dentated suture at its most constricted part.

In the same specimen, which is perhaps young, the proper frontal bones appear to be very narrow, the outer third of each being formed by a fringe of apparently distinct marginal ossicles (*x*); but these seem, eventually, to become completely united with one another, and with the frontals. The surface of the frontal shield exhibits a pitted and reticulated sculpture, like that of the occipito-parietal, which is most distinct on the marginal ossicles. The dots of enamel are scanty, and scattered at wide intervals.

The *basis cranii* (*a*, *b*, *c*) is formed by a layer of bone, which is continuous, and presents no trace of sutures, between *a* and *b*. Behind *b* it is defective for some distance, but reappears in front of *c*. It doubtless represents, in the greater part if not the whole of its extent, the *parasphenoid* of ordinary fishes.

Between the orbits this *parasphenoid* has the form of a stout bar of bone, grooved above, convex and smooth below; but it becomes flattened out from above downwards, both anteriorly and posteriorly. Anteriorly, it ends as a spatulate plate (Plate VIII., fig. 3*a*), which has prominent lateral margins, bounding a transversely concave under surface, over which are scattered multitudes of minute granular teeth, those on the margins of the plate being somewhat larger than the rest. The dentigerous plate may represent a vomer, but in no specimen that I have seen can it be distinguished from the parasphenoid.

Posteriorly, the parasphenoid is broken, but probably passed into the flat bony floor of the parieto-occipital division of the skull, which may either be an extension backward of the parasphenoid, such as exists in the sturgeon, or may be formed by coalescence of the latter with a true basi-occipital.

Above its spatulate dentigerous part, the basal bone passes upwards and outwards into strong lateral plates (Plate VIII., fig. 1, *Pr. f.*), which are concave outwards, and unite with the frontal shield. They represent the *prefrontals*.

Each prefrontal gives off from its anterior end, just above the rounded extremity of the dentigerous plate, a stout process (Plates VII., fig. 6, VIII., figs. 1 and 3, *d*), which passes downwards and outwards, and ends by a free rounded extremity at the margin of the gape, close to the anterior end of the maxilla. This appears to represent the process of the prefrontal bone with which the palatine articulates in ordinary fishes.

The interorbital space above the parasphenoid, from the posterior margins of the prefrontals as far as a point a little in advance of the junction of the fronto-nasal and parieto-occipital shields, seems to have been devoid of ossifications answering to the orbitosphenoids and alisphenoids; but further back the sides of the parasphenoid pass indistinguishably into the *pro-otic* bones. Each of these is a large plate of bone, rising perpendicularly towards the roof of the skull, which it nearly reaches in front. Further back it sends out two great processes, one superior and the other inferior, at right angles to its own plane.

The superior process (Plate VIII., fig. 1, *e*), curving outwards abuts against the under surface of the occipito-parietal shield, close to the middle of its outer margin, and furnishes an articular facet for the proximal end of the hyomandibular bone (Plate VIII., fig. 2, *H.M.*).

The superior process of the pro-otic is separated by a deep oval fossa from the inferior process (Plate VIII., figs. 1 and 2, *f*), which is a stout plate of bone, convex from above downwards on its outer surface, and ending in front by a free thick edge, represented somewhat too round in Pl. VIII., fig. 2. The lower incurved edge of this scroll-like plate does not come into contact with the osseous basis cranii, which hereabouts begins to be defective.

The root of the superior process (Pl. VIII., fig. 1 *e*) separates two slit-like foramina which lead into the interior of the skull, and probably gave exit to divisions of the fifth nerve. From the upper and external edge of the inferior process a vertical bar of bone is sent off and, abutting against the superior process, bounds an oval fossa behind.

Externally and posteriorly, the pro-otic abuts, by an abruptly truncated and perpendicular face, against another stout lateral osseous mass (*g*), which appears to represent the *opisthotic* and *exoccipital*. From this three processes pass, one ascending, which lies against the vertical bar (f^1) of the pro-otic; a second external and ascending process (Pl. VIII., figs. 1 and 4, *h*,) passes upwards and backwards to unite with and support the supra-scapular part (*S. Sc.*) of the parieto-occipital shield. The third process (Pl. VIII., figs. 1 and 4, *i*) is

directed outwards from near the base of the skull (perhaps arising chiefly from the parasphenoid), and ends in a free obtuse surface, against which the middle of the hyomandibular suspensorium abuts (Pl. VIII., fig. 2). Behind the part from which these processes are given off, the opisthotic and exoccipital ossification is continued backwards as a vertical plate, which forms a large part of the postero-lateral walls of the cranial cavity. Between this plate and the processes of the opisthotic there is a deep fossa, floored below by a thin plate of bone (Pl. VIII., fig. 4 *k*) which forms a sort of continuation of the lower edge of the third process of the opisthotic (*i*) into the base of the skull.

The lateral "exoccipital and opisthotic" plates do not reach the roof of the skull superiorly, but end in a free edge, posteriorly; they diminish to a height of not more than one-eighth of an inch above the base of the skull. From the point where it is lowest (Pl. VIII., fig. 4 *l*) the base of the skull rapidly diminishes in breadth, and ends at *c*, by a free rounded extremity, which is so fractured that its precise shape is not determinable.

A thin plate of bone (Pl. VIII., fig. 4 *m*) forms a low arch over this part of the skull, and is continuous with the basal plate below.

It is not improbable that this arch may represent an anterior vertebra corresponding with one of those which, in the *Ganoidei*, commonly coalesce with the occipital region of the skull.

The pro-otic bones of opposite sides are not separated by a greater distance than the width of the presphenoidal bone in front and below, but, above, they are somewhat more distant.

The anterior end of the snout of *Macropoma* is constituted by a single bone having the form of a triangle with its base downwards, with a convex anterior and concave posterior surface (Plate VII., figs. 3, 4, and 6). The convex face is beset with small cylindroidal teeth, but at the postero-lateral angles of the oral, or lower, margin of the plate, several larger curved and pointed teeth are attached.

The posterior concave face is smooth, and seems to have played over the ethmoidal cartilage.

This bone may either represent the *premaxillæ* coalesced, which is the interpretation that first suggests itself; or, on the other hand, it may be a *vomer*, such as would be formed if the vomerine teeth of *Lepidosiren* were supported upon a common bony base. In the latter case the premaxillæ remain to be discovered.

The hyomandibular, quadrate and pterygoid elements of the face are represented in *Macropoma* by a great triangular plate of bone, in which I have not been able to discover any distinct sutures. The outer and upper surface of this "pterygo-suspensorial" bone, and its general form, are well shown in fig. 3., Pl. VII., while the proper contour of the hinder half of its lower edge is seen in fig. 6 of the same plate. The inner surface of an entire pterygo-suspensorial bone is beautifully displayed in No. 4246 of the British Museum collection.

The whole plate is so twisted upon itself that, anteriorly, its surfaces look almost downwards and upwards, while posteriorly, they look inwards and outwards. The anterior angle is compara-

tively thin and rounded off, and extends forwards to the level of the prefrontals (Pl. VII., fig. 3; Pl. VIII., fig. 3), where it articulates with the bone, *Pl.*, which it underlies.

The posterior inferior angle is formed by a very stout neck which bears the transversely elongated condyle for articulation with the mandible. This condyle has a subcylindrical pulley-shaped articular surface, somewhat excavated in the middle, like the distal end of a humerus.

The upper and posterior angle of the bone, *H. M.* is likewise formed by a strong neck, which expands above into a broad head, and articulates thereby with the side walls and roof of the skull (Pl. VIII., fig. 2).

The outer and upper surface of this bone is remarkably smooth and polished. The inner surface, on the contrary, with the exception of a small strip belonging to the posterior part of the quadrate, is evenly covered with minute asperities, which have, for the most part, more the aspect of tubercles of enamel than of teeth. Along the outer edge, however, they become longer, sharper, and more tooth-like.

In Pl. VIII., fig. 3, the anterior end of the left pterygo-suspensorial bone is seen to pass to the ventral side of, and become connected with, the bone *Pl.*, which is convex from side to side below, and correspondingly concave above. The inner edge of this bone articulates with the prefrontal, and I conceive that it represents the *palatine*.

The concave upper surface of the right palatine is well seen in No. 4241 in the British Museum; and here again the bone is connected on the inner side with the prefrontal, and on the outer, with the anterior end of the pterygo-suspensorial. In the specimen represented in Pl. VIII., fig. 3, there are no teeth upon the oral surface of either of these bones; but I believe that such teeth existed, inasmuch as No. 4237 B.M., the head of which is represented in fig. 3, Pl. VII., shows, in the interior of the mouth, a convex plate, *Pl.*, covered with small teeth. In this specimen and in No. 4252 B.M. (Pl. VII., fig. 6) certain sharp, curved, conical teeth, *bb*, are visible, which certainly belong neither to the maxilla nor to the bone *x*, and may have been attached to the palatines.

The *Maxillæ* (Pl. VII., fig. 6; Pl. VIII., figs. 2 and 3) are slender bones which lie alongside the outer margin of the pterygo-suspensorial bone, and form the edge of the gape. Their lower edges are beset with small curved teeth. Their anterior connexions are not displayed in any specimen I have seen. Posteriorly, each abuts upon the apex of an elongated triangular "postmaxillary" bone which fills up the interval between the suborbitals, opercula, and mandible, and covers the quadrate articulation.

Each ramus of the mandible is very stout, and is deepest in the middle third of its length (Pl. VII., fig. 6), where its upper margin is nearly straight. Posteriorly. the upper margin diminishes in height rather gradually; but, anteriorly, it falls rapidly, being as it were excavated towards the symphysis.

In the mandibles, which are represented in Pl. VII., the greater part of the angular-articular and dentary elements have been broken away leaving only the plate which answers to the splenial of reptiles (fig. 3., *Spl.*) And it is this plate which gives rise to the height and straightness of the upper edge of the middle third of the ramus.

The angulo-articular element of the mandible, which forms the outer part, if not the whole, of the ramus at the articulation, rapidly diminishes in height, and leaves the outer surface of the splenial bare as it passes forwards. It then meets the dentary, fitting into a V-shaped space afforded by the latter.

The dentary, passing forwards, suddenly rises into a kind of shoulder, *y* (fig. 4, Pl. VII.), which applies itself to the anterior part of the outer surface of the splenial.

In uninjured specimens the whole outer surface of the angulo-articular is covered with tubercles of enamel. Similar, but more scattered, tubercles ornament the dentary; but the outer surface of the splenial, exposed between the process *y* and the front and upper margin of the angular-articular, is perfectly smooth.

There is a distinct suborbital half ring (Pl. VII., fig. 1), formed to all appearance of a single bone, or of several bones which have coalesced, and presenting a granular external sculpture. The posterior part of the suborbital ring is much broader than the anterior, and abuts upon the operculum, behind and below which it comes into contact with the triangular postmaxillary bone: in front and above it, exhibits a deep notch.

The ornamentation of the suborbital bones consists of pits and reticulated ridges, with scattered tubercles of enamel.

The *operculum* (Pl. VII., fig. 1, *op.*), is a large four-sided bone. Its upper margin is shortest; its front margin, which is as long as the distance from the roof of the skull to the lower edge of the triangular "post-maxillary" bone, longest. The posterior margin is much shorter, so that the lower edge of the operculum runs very obliquely, from above and behind downwards and forwards.

Traces of a *subopercular*, much smaller than the operculum, are discoverable in some specimens.

When the outer surface of the operculum is complete, it is covered with close-set conical enamel tubercles, like those of the roof bones of the cranium.

Two large *jugular plates* occupy the whole interval * between the rami of the mandible. The inner, opposed, margins of these plates are straight, the outer, evenly convex.

The *hyoidean arch* is strong and well ossified, and is connected with the hyomandibular by a very strong "*stylo-hyal*" (*St. h.*, figs. 3 and 6, Pl. VII.).

Each *branchial arch* is, apparently, a single arcuated bone, deeply grooved posteriorly. I can count only four on each side in the

* In No. 25,872, of the British Museum Collection, the surface of the jugular plates is perfectly preserved, and is ornamented with tubercles of enamel, which are set, evenly, and pretty close together, over its whole surface.

specimen (belonging to the Earl of Enniskillen), which best displays these structures.

The resemblance of the branchial apparatus of *Macropoma* to that of *Cœlacanthus* is still further increased by the large spatulate bone, which, in *Macropoma*, terminates the median part of the branchial skeleton posteriorly. No specimen has exhibited the anterior moiety of the median branchial skeleton, so that I am unable to say whether it has or has not the form of a crucial bone.

I have not been able to procure detached teeth of *Macropoma* for microscopic examination. The bases of even the largest teeth are perfectly smooth, and present no longitudinal grooves or foldings.

Macropoma substriolatum, Huxley (Plate IX. and X.).

I have abstained hitherto from referring to a specimen of a fossil fish to which Sir Philip Egerton refers in the following terms, in the note at p. 19 the "Preliminary Essay" of Decade X.:—

"In the Woodwardian Museum, at Cambridge, there is the head and part of the trunk of a *Cœlacanthus*, from the Kimmeridge clay at Cottenham. The head shows the frontals, prefrontals, and lower jaw, with the tympanic attachments. The glossohyal plate is double, as in *Holoptychius*. The scales are roughly undulate, coarser in pattern than in *Undina*, *Cœlacanthus*, and *Holophagus*, but not absolutely tuberculate, as in *Macropoma*. One fin is preserved, probably the left pectoral. It is lobate, broad, and strong. The operculum is triangular, the frontals short, and the prefrontals descend at an abrupt inclination."

Pl. IX. represents the ventral surface of the body of the Cœlacanth fish of which Sir Philip Egerton speaks, of the size of nature.

It is covered with large, thin, cycloidal scales, each of which is divided into a large smooth region, overlapped in front and on each side by the neighbouring scales, and a comparatively small free part, which presents numerous close-set elongated dots, or short ridges, of enamel. The dots and ridges are distinct, and their long axes are roughly parallel with that of the body, though the lateral ones sometimes show a certain tendency to diverge from the long axis of the scale itself.

The left pectoral fin (*P*) is very well shown, and exhibits, at fewest, fifteen fin-rays, the bases of which are so disposed as to inclose an oval "lobe," which is completely covered by small scales, not more than half, or a third, as large as those of the body, but possessing the same ornamentation.

The proximal ends of the fin-rays are unarticulated, but seem to be hollow; distally they become broader and flatter, and then narrow to points, without becoming longitudinally subdivided. Rather more than the distal half of each, apparently, was divided, transversely, into short broad joints.

The surfaces of these fin rays are quite smooth.

Four views (one-half the size of nature) of the head of this fish are given in Pl. X.; it is composed of a parieto-occipital and a frontal moiety, as in *Macropoma*, and the former (*Pa*) is divided by a median suture into two. The frontal shield is greatly crushed, and its precise form cannot be made out, but so much of it as remains is like that of *Macropoma*.

The general arrangement of the suborbital bone or bones (figs. 2 and 3) is plainly similar to that in *Macropoma;* and the same likeness extends to the operculum (*Op*), to the strong pulley-like end of the quadrate (*Qu*),—divided in the present fish by a longitudinal depression, so as to resemble the articular end of a phalanx,—and to the lower jaw.

I suspect that *b*, fig. 2, represents the *post-maxillary* bone of the Chalk *Macropoma*, in which case the flat bone *a* (figs 2 and 3) will probably be the *suboperculum*.

The jugular bones (fig. 4, *G*) are double, and closely resemble those of *Macropoma* in form: they present an ill-defined rugosity, but no proper sculpture, and no trace of enamel, resembling in this respect the opercula and the other bones of the head.

At *a*, fig. 4, clear traces of ossified branchial arches are visible.

In its general characters it is clear that this fish completely resembles *Macropoma;* and considering the frequency with which the enamel is found to have disappeared from the cranial bones of fishes of the latter genus in the Chalk, no weight can, I think, be attached to this apparent difference.

The scales are quite similar to those of *Macropoma* in form, and in the proportion of the sculptured to the unsculptured part (the unsculptured part in the scale 3 of plate 65 *b* of the "Recherches" is far too small), but the enamel tubercles are far less regularly oval, and tend to become elongated and ridge-like.

I think, therefore, that this may safely be regarded as a distinct species, for which I propose the name of *Macropoma substriolatum*.

I am indebted to Prof. Sedgwick and Mr. H. Seely, for the opportunity of figuring and describing the specimen on which this species is based.

The common characters, classification, and distribution of the CŒLACANTHINI.

The fossil fishes which have been described above under the names of *Cœlacanthus*, *Undina*, *Holophagus*, and *Macropoma*, have the following characters in common :—

1. The body is covered with thin cycloidal scales, the exposed portion of which is ornamented with tubercles or ridges of enamel.

2. There are two dorsal fins, the anterior supported by a single broad and plate-like interspinous bone; while the posterior has a forked interspinous bone. There is a single anal fin, and a very large caudal, the upper and lower lobes of which are equal; the spinal column, which traverses it without being at all bent up, ending in a filament with small supplementary fin rays.*

In the caudal fin, interspinous bones are interposed between the fin-rays and the neural and subvertebral spines.

3. The paired fins are obtusely lobate. The pectoral arch is strong and well ossified, and there are two large pelvic bones. The fin-rays of all the fins are not articulated at their proximal ends, and are longitudinally undivided. The ventral fins are placed but very little behind the anterior dorsal, and the anal lies below the posterior dorsal.

4. The spinal column is unossified, the notochord being persistent, and only the neural and subvertebral arches ossified. If ribs existed at all, they were remarkably small.

5. The roof of the skull is formed by a parieto-occipital and a frontal shield, which meet at an obtuse angle. The surface of each of these is ornamented with tubercles of enamel.

6. There is a large "pterygo-suspensorial" bone representing the hyomandibular, quadrate, and pterygoid bones of ordinary fishes.

7. There are two jugular bones and no proper branchiostegal rays.

8. The branchial and hyoidean arches are well ossified, and there is a median bone in the branchial series which has a spatulate posterior termination (not observed in *Holophagus* and *Undina*).

9. The air bladder has ossified walls.

10. The teeth are for the most part "en brosse" or tubercle-like and minute; but a few are larger, acutely pointed (*Undina ? Holophagus ?*). These larger teeth exhibit no plications at their bases.

These being the common characters of the *Cœlacanthini*, the next point is to obtain clear definitions of the several genera which compose the group.

Cœlacanthus is readily enough distinguished from the rest by

* This peculiarity of the caudal fin has not not been actually observed in *Macropoma*; but it is hardly doubtful that the cretaceous genus resembled the others in this particular.

the ornamentation of its scales, which is disposed in converging ridges, not in tubercles; by the ridged ornamentation of the rami of the mandible and of the jugular bones; and by the absence of spines upon the fin-rays of the median fins.

In *Macropoma*, on the other hand, the scale ornament is made up of distinct tubercles; the jugular bones and mandibular rami are covered with tubercles, not with ridges; there are single or double rows of stout spines upon the anterior edges of the fin-rays of the median fins, which are inarticulated through the greater part of their length.

In *Holophagus* the scale ornament is in ridges, like that of *Cœlacanthus*. There are small spines, sometimes in more than two rows, upon the fin rays of the anterior dorsal and both lobes of the caudal fins; but I see none upon the second dorsal or upon the anal. The median fin-rays are articulated through more than half their length.

Of the two species of *Cœlacanthus* (= *Undina*) described by Count *Münster*, *C. Kohleri* is distinguished by the ornamentation of its scales "resembling flies' eggs," and by the rows of small spines upon the fin rays of the first dorsal and caudal fins.

The beautiful specimen of this species, the property of the Earl of Enniskillen, which is before me, shows the first and second dorsal fins, the pectorals, and the ventrals; the tail is wanting. The fin-rays of the anterior dorsal are spinous, and the spines are set in a double row along the anterior edges of the fin-rays, much as in *Macropoma*, and unlike *Holophagus*. The fin-rays remain undivided much further from their base than in *Holophagus*, and in this respect, also, more resemble *Macropoma*.

The sculpture has disappeared from the cranial bones, and the inner sides of the two jugular bones are exposed, so that nothing can be said upon this point. The scales are represented by mere bony films.

The head is altogether similar in form to that of *Macropoma*. There is a well ossified parasphenoid. The stylohyal, the operculum, the pectoral arch, and the lower jaw, so far as they are preserved, are very like those of *Macropoma*.

The only teeth which are visible are small and granular, and resemble those of the pterygo-suspensorial and parasphenoid bones in *Macropoma*. The absence of pointed teeth is a circumstance of merely negative import, to which I am not disposed to attach any importance.

Of *Cœlacanthus* (*Undina*) *striolaris* I have seen no specimen, but while Münster's figures show that, in all important respects, it resembled *C. Kohleri*—he assigns to it scales with a striated ornamentation, and fin-rays without spinous ornamentation. Putting aside the teeth (the absence of sharp teeth in *Undina* and of granular teeth in *Cœlacanthus* not being proved), I see no character by which this species is separable from *Cœlacanthus*, while *C. Kohleri* appears to be equally indistinguishable from *Macropoma*.

If this supposition should be borne out by the examination of more perfect specimens of *Undina*, the genera of Cœlacanths would be reduced to three,—*Cœlacanthus*, *Holophagus*, and *Macropoma*; and, in the ornamentation of its scales and fin-rays, *Holophagus* would occupy the same intermediate position between the other two genera as it does in time. However, it is better, for the present, to retain *Undina* as a distinct genus.

Bearing in mind the range of the Cœlacanths from the Carboniferous to the Chalk formations inclusive, the uniformity of organization of the group appears to be something wonderful.

I have no evidence as to the structure of the base and side walls of the skull in *Cœlacanthus*, but the data collected together in the present Decade show that, in every other particular save the ornamentation of the fin-rays and scales, the organization of the Cœlacanths has remained stationary from their first recorded appearance to their exit. They are remarkable examples of what I have elsewhere termed "persistent types," and, like the Labyrinthodonts, assist in bridging over the gap between the Palæozoic and the Mesozoic Faunæ.

Description of Plates—II. to X.

Plate II.

Fig. 1. A specimen of *Cœlacanthus lepturus*, of the natural size. In the Museum of Practical Geology.

Fig. 2. The anterior part of the body enlarged.

Figs. 3, 4. Scales magnified.

Plate III.

Fig. 1. *Cœlacanthus lepturus*, of the natural size.

Fig. 1*a*. Scales magnified.

Fig. 1*b*. Part of the ornamentation of the operculum magnified.

Fig. 2. The hinder part of the body of a *Cœlacanthus lepturus*, of the natural size, showing the remains of the ossified air-bladder.

Fig. 3. Under view of the head of a *Cœlacanthus lepturus*.

All these specimens are in the Museum of Practical Geology.

Plate IV.

Fig. 1. Magnified view of the counterpart of the specimen represented in Plate III., fig. 3.

Fig. 2. The mandible of the same inverted.

Fig. 3. Under view of the head of a specimen in the collection of Edw. Binney, Esq., F.R.S.

Fig. 4. Pelvic bones of *Cœlacanthus lepturus*. In the Museum of Practical Geology.

Fig. 5. The two dorsal fins of a *Cœlacanthus lepturus*. In the Museum of Practical Geology.

Fig. 6. Caudal extremity of a specimen of *Cœlacanthus lepturus*. Magnified 1½ times.

Plate V.

Figs. 1, 2, 3, 4. *Cœlacanthus elegans*. From specimens in the collection of Sir Philip Egerton, Bart.

Fig. 5. *Cœlacanthus caudalis*. In the collection of Sir Philip Egerton, Bart.

Figs. 5, 6. *Cœlacanthus elongatus*. In the Museum of the Geological Survey in Ireland.

Plate VI.

Holophagus gulo, with a scale and fin-rays magnified. In the Museum of Practical Geology.

Plate VII.

Fig. 1. *Macropoma Mantellii*. One half the size of nature. In the Museum of Practical Geology.

Fig. 2. A detached air-bladder of *Macropoma Mantellii*. One-half the size of nature. In the British Museum.

Fig. 3. The head of *Macropoma Mantellii* figured by Prof. Agassiz, 'Recherches' II., Pl. 65 d, fig. 2, the matrix having been further cleared away.

Fig. 3*a*. The teeth enlarged. In the British Museum (No. 4237).

Fig. 4. A side view of the snout of the *Macropoma Mantellii*. Figured by Prof. Agassiz, l.c. Fig. 1. In the British Museum (No. 4,270).

Fig. 4*a*. Front view of the dentigerous "premaxillary" bone. Magnified.

Fig. 4*b*. The upper end of the pectoral arch of this specimen.

Fig. 5. A pectoral fin of a *Macropoma Mantellii*. In the British Museum (No. 4,258).

Fig. 6. The head of a *Macropoma Mantellii*. Figured by Prof. Agassiz, l.c. Fig. 3. In the British Museum (No. 4,252).

Fig. 1.

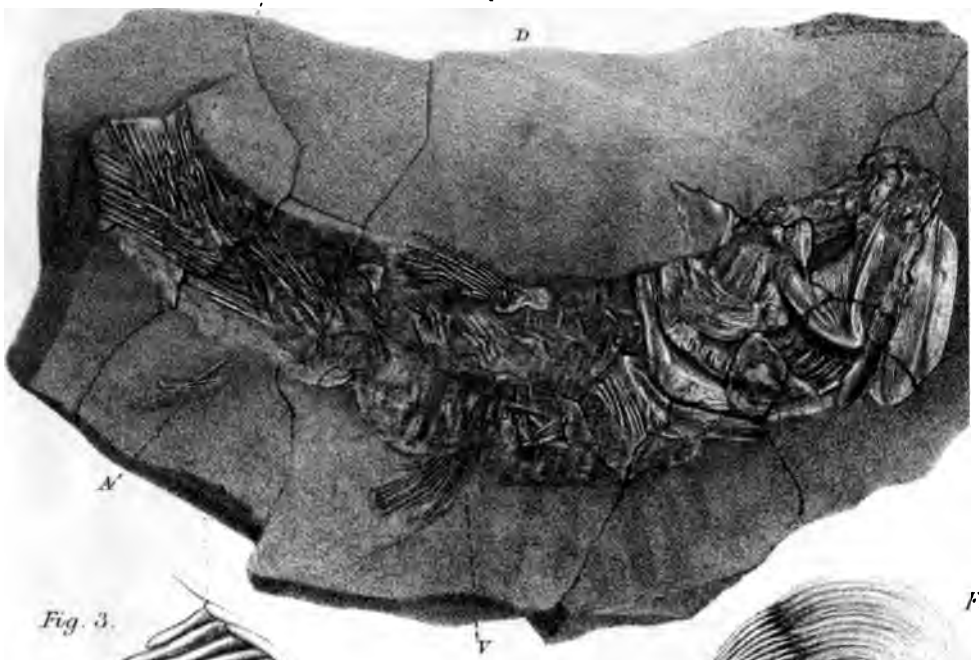


Fig. 3.

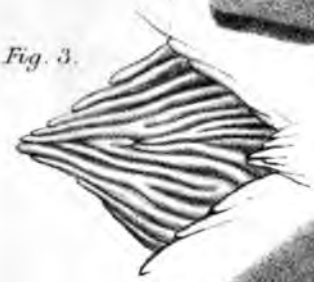


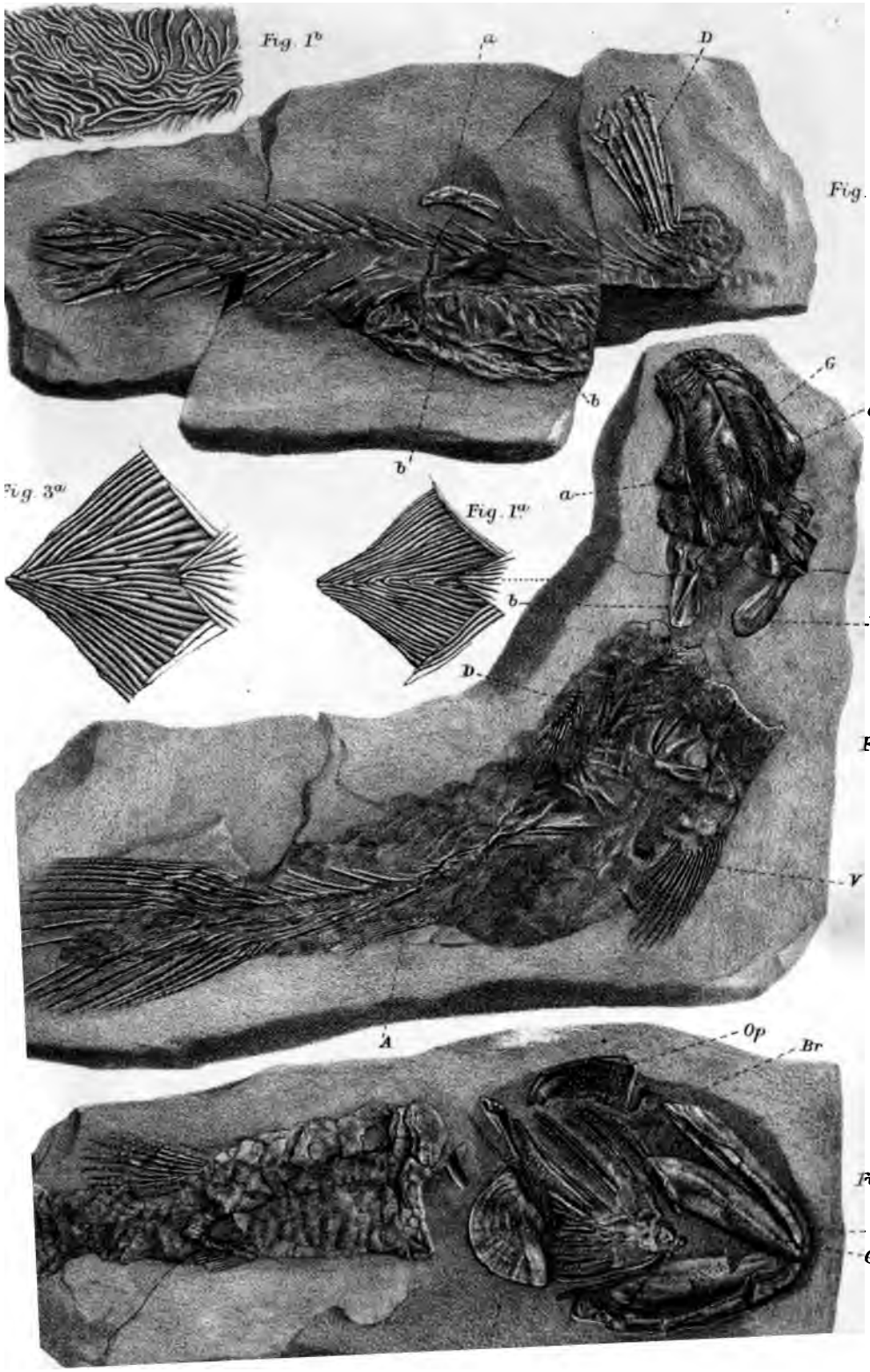
Fig. 4

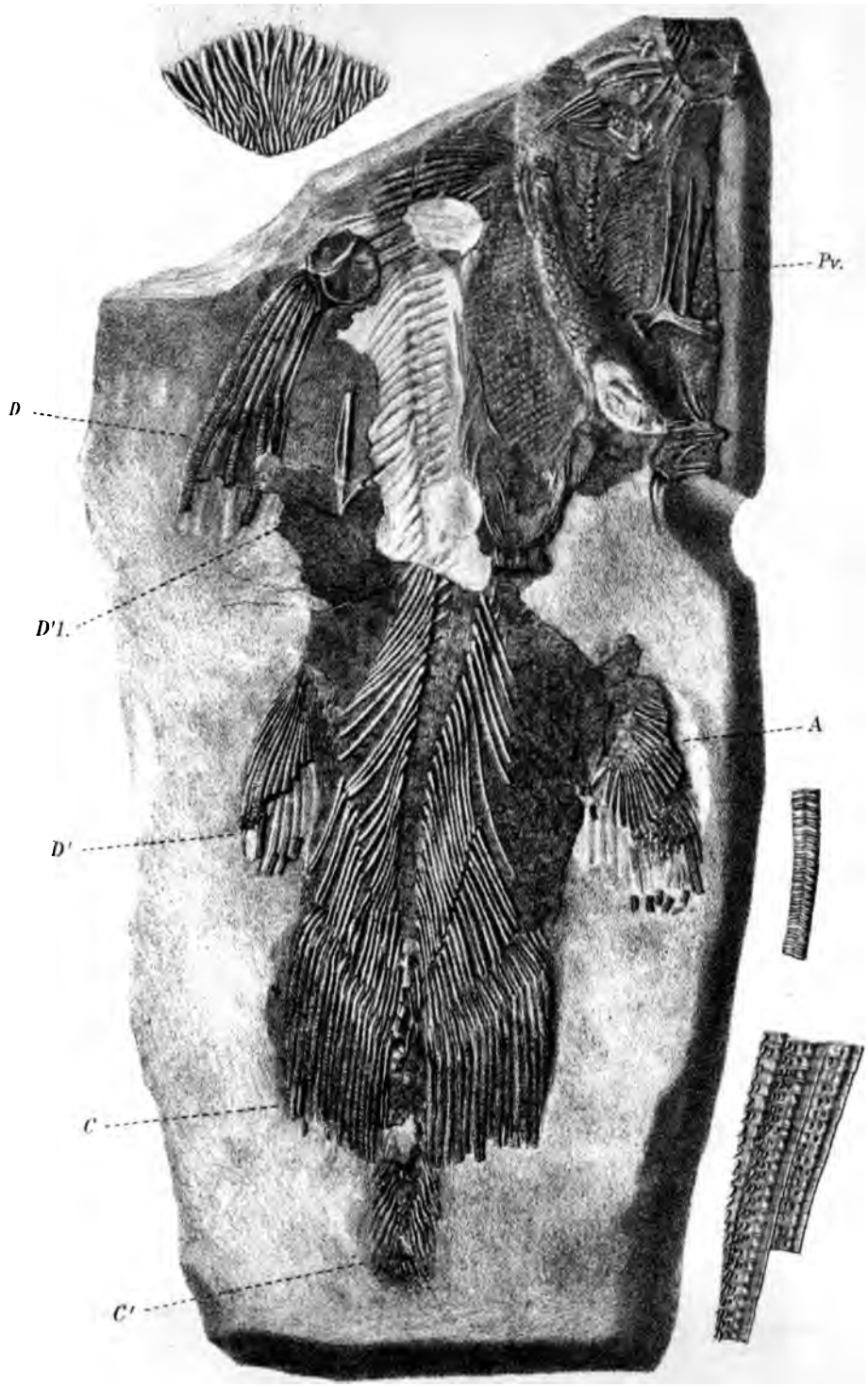


Fig. 2



Calacanthus lepturus (Agassiz)


Fig. 1b
a
D
Fig. 2.
b
b
G
a
Fig. 3a
Fig. 1a
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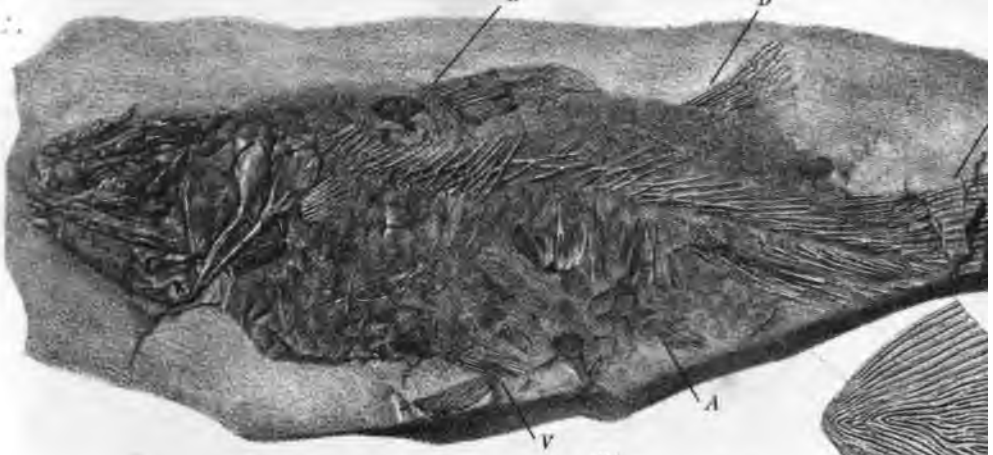
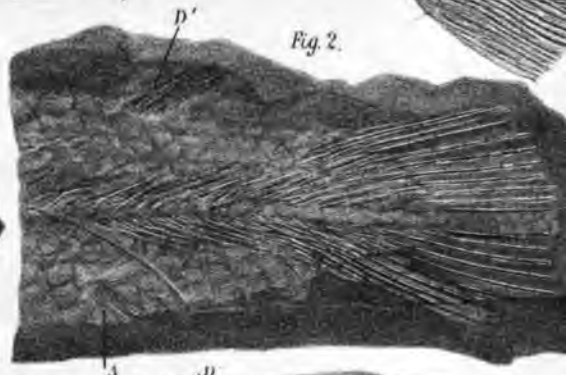


Fig. 2.





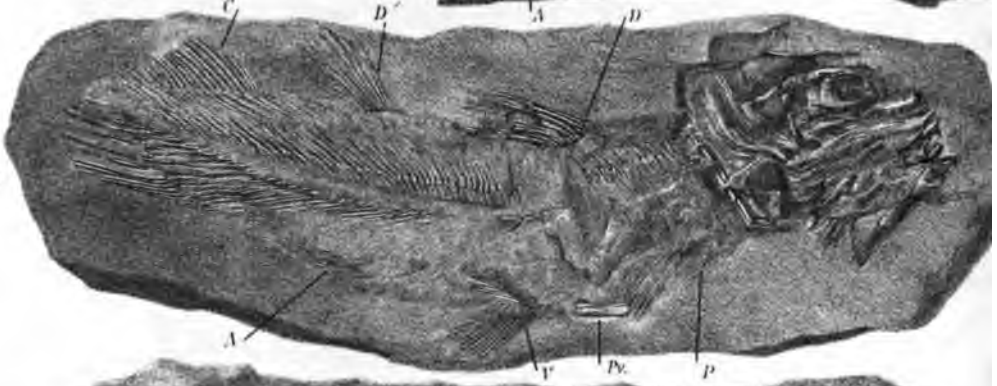
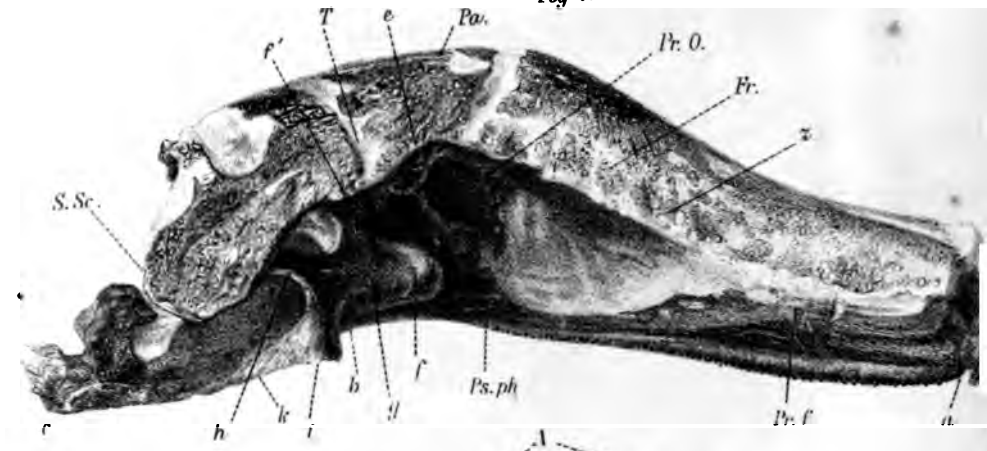
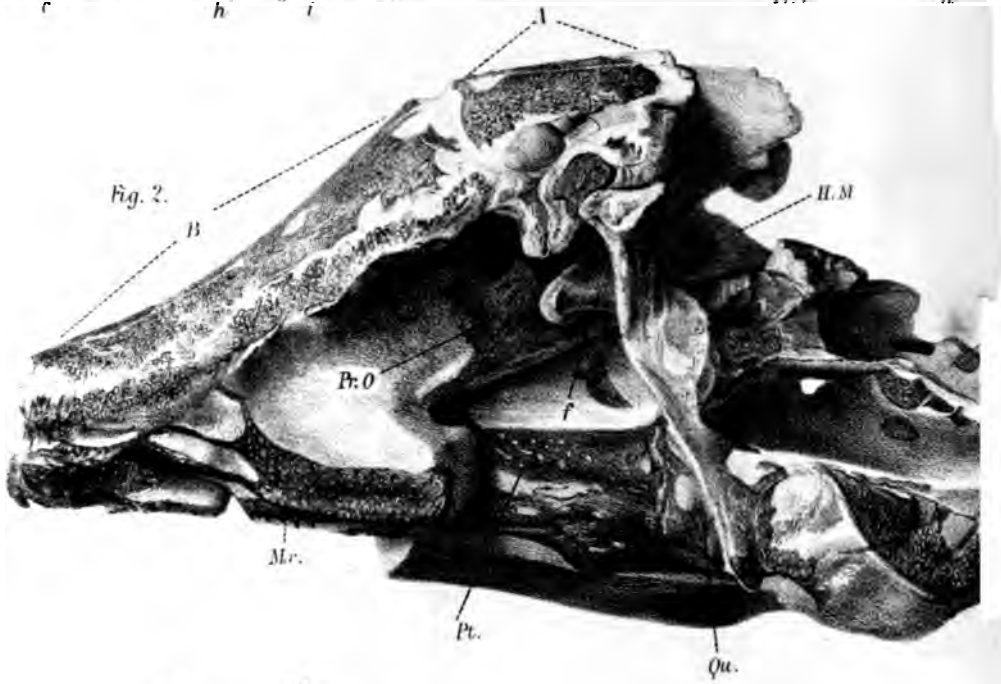


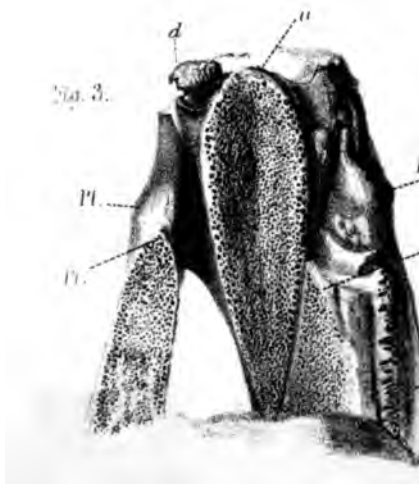




Fig 1.









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Macropoma substriolatum (Huxley)



Macropoma substriolatum (Huxley)

Plate VIII.

The skull of a *Macropoma Mantellii*. In the collection of the Earl of Enniskillen.

Fig. 1. A view of the right side; Fig. 2, of the left side; Fig. 4, from behind.

Fig. 3. The under surface, so far as the matrix allows it to be seen.

Plate XI.

The body of *Macropoma substriolatum*, with a single scale, magnified. In the Woodwardian Museum, Cambridge.

Plate X.

The head of the same specimen from above (Fig. 1), the sides (Figs. 2 and 3), and below (Fig. 4). One half the size of nature. In the Woodwardian Museum, Cambridge.

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GEOLOGICAL SURVEY

OF

THE UNITED KINGDOM.

Figures and Descriptions

ILLUSTRATIVE OF

BRITISH ORGANIC REMAINS.

DECADE XIII.

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PREFACE.

THIS Decade contains descriptions and figures of nine genera and ten new species of fish.

Of these, seven were found in the Lower Lias at Lyme Regis, six of which have been described by Sir Philip de Malpas Grey Egerton, and one, *Holophagus gulo*, before described by him, is further described and figured by Professor Huxley. One from the Kimmeridge Clay, another from the Upper Chalk, have also been described by Sir Philip Egerton, and one from the Gault by Dr. Albert Günther.

In earlier Decades Sir Philip Egerton had already described forty-one species; and the Geological Survey is therefore now indebted to that distinguished Ichthyologist for the description of no fewer than forty-nine new species, accompanied by admirable lithographic drawings.

ANDREW C. RAMSAY,
Director-General.

Jermyn Street,
25th April 1872.

maxillary, and most probably armed with teeth like this bone. The *maxillary* (right side) is long, flat, smooth, 2⅝ inches long and ¼ inch broad; it terminates anteriorly in a tapering process, by

BRITISH FOSSILS.

DECADE XIII. PLATE I.

THRISSOPATER SALMONEUS.

THE entire length of the fossil is 25½ inches, the depth across the middle of the abdomen 5¼; it lies on the right side. The *anterior* half, to the commencement of the dorsal fin, shows a great portion of the scales in their natural arrangement, as well as the general outlines of the trunk and head. This portion can be lifted out of the matrix in which it is embedded, and several points obscure on one side can be made out on the other. Also the greater part of the vertebræ of this region can be distinctly traced below the thin overlaying integument. The *posterior* half, from the commencement of the dorsal fin, consists in an admirably preserved vertebral column, greater part of the caudal fin, a few rays belonging either to the ventral or anal fin and the right ovary. Although the general outline of the head is well preserved, the bones are much broken and difficult to trace.

Head.—The head resembles in its general outline that of a salmon; it is compressed, with the facial portion produced and pointed; its upper surface was convex, a ridge running along the median line, from which the lateral halves slope downwards. The entire length of the head (to the end of the operculum) is 6¼ inches, or contained 2⅔ in the length of the vertebral column. The *mouth* was very wide, the mandibulary joint being far behind the eye, and even behind the middle of the length of the head; the jaws armed with series of small, solid, pointed, slightly curved teeth. The *eye* appears to have been of moderate size, situated at the beginning of the second third of the length of the head. It is evident from a comparison of the two sides of the fish that the inter-maxillary formed the mesial portion of the margin of the upper jaw, and the maxillary the lateral. Part of the *inter-maxillary* is preserved on the left side, but it is much broken; it was short, certainly not more than one-third of the length of the maxillary, and most probably armed with teeth like this bone. The *maxillary* (right side) is long, flat, smooth, 2⅝ inches long and ¼ inch broad; it terminates anteriorly in a tapering process, by

which the junction with the inter-maxillary is effected. It is armed with a series of about 30 small pointed teeth, some of which are slightly grooved at the base. The supplementary bone (*sp.*) is thin, sabre-shaped, extending as far back as the maxillary, namely, to the coronoid process of the mandible. The *mandible* is very strong and long, 3⅝ inches; it has two longitudinal grooves, one just below the dentigerous margin, and the other near its lower edge. The teeth with which it is armed appear to have formed a single series; they are small and closely set in the front part of the bone, and considerably larger on its middle (left side). The *infra-orbital* bones cannot be distinguished singly, but those behind the eye are much enlarged, covering the cheek entirely, and extending to the margin of the preoperculum. *Opercles* thin, membranaceous, smooth, much dilated, especially the angular portion of the preoperculum, the edge of which is subsemicircular; the boundary line between the operculum and suboperculum can be traced on the left side, where it ascends in an oblique direction from the angle of the preoperculum, the shape of the operculum being subtriangular, and that of the suboperculum (*so.*) subsemicircular. The interoperculum is long, narrow. Two branchiostegals (*b.*),—the upper long and narrow, the lower broader and shorter,—are well preserved on the right side.

On the same (right) side part of the gill-cover is broken away, and traces of the *gills* (*g.*) are visible, showing that the branchial lamellæ were long, slender, closely set, reaching to the humeral margin of the gill-cavity.

The bones of the *humeral* arch are either dilated or covered by a dilated, semiossified dermal layer, which above the root of the pectoral fin passes into a very long, pointed appendage (Fig. A. right side) similar to, but much more developed than the axillary appendage of *Chanos*. It is formed by five or six enlarged imbricate scales, about 4 inches long, and extending to the level of the fourteenth or fifteenth vertebra.

Of the *vertebral column* 46 vertebræ are visible, the anterior two or three being entirely hidden by the overlying parts, so that the total number amounts to 48 or 49. The vertebræ do not differ much from one another in form or length; they are slightly constricted in the middle, deeply biconcave, and somewhat deeper on the edges than long. The *ribs* are entirely hidden, and of the neural and humeral processes only fragments are preserved. The neural spine of the antepenultimate vertebra (*n.*), which is modified into a support of the upper caudal lobe, is very strong, arising from the upper lateral half of the vertebra, and directed back and upwards.

Fins.—The dorsal fin is so much broken up, that scarcely more than its position can be ascertained; it appears to occupy nearly the middle of the total length, being placed opposite to the nineteenth to twenty-fifth vertebræ, and from the fragments of the rays we may conclude that their number was not less than 14, none of them being distinguished by unusual thickness. Of the anal fin (*a.*) only two or three small, slender fragments are preserved; they are opposite to the thirty-ninth and forty-second vertebræ. The caudal fin is deeply forked with strong, broad, distinctly articulated rays, the joints being but little longer than broad. The pectoral fin consists of 17 rays of the usual strength and arrangement; it is pointed, and 2½ inches long, that is considerably shorter than the overlying axillary appendage. Of the ventral fin (*v.*) only the basal portion of three rays is preserved; it lies now opposite to the twenty-sixth vertebra, so that its position was opposite to or behind the posterior dorsal rays.

The *scales* are firm and rather thick; of those of the side about one-half of each scale is exposed, finely but deeply striated, the upper striæ being a little wavy. The scales are small, about 50 may be counted in a transverse series, descending obliquely from the back in front of the dorsal fin towards the abdomen; they increase in size in the vicinity of the humeral arch and pectoral appendage. I cannot discern a lateral line.

A ridge may be traced along the median line of the abdomen, from which I conclude that the belly in front of the ventral fins was compressed into a sharp ridge, as in many Clupeoids, Cyprinoids, and Characinoids.

Finally, some soft organs are to be mentioned. An elongate body (*o.*), pointed anteriorly and more obtuse posteriorly, slightly concave on its inner surface, is evidently the right *ovary*. It is situated above the ventral fin, 5 inches long, and finely granular at its surface. Above it and above the vertebral column a mass (*x.*) is spread out like thick skin, which I cannot determine with certainty. It may be the other ovary displaced and flattened by pressure. A ring-like body, grooved on its outer and hinder surface, situated below the nineteenth vertebra (right side), appears to be a loop of the intestine.

It is not difficult to determine the systematic position of this fish. The structure of the upper jaw, shielded cheeks, form and position of the fins, striated scales, axillary appendage, compressed abdomen, &c. are characters which lead us at once to the large marine forms at present associated with the Clupeoids, *Chanos* and *Elops*. Several fossil species of the former genus have been described by Viennese ichthyologists (Denkschr. Ak. Wiss. Wien, 1863, XXI.), but our fish is at once distinguished by the develop-

ment of the dentition and compressed abdomen. In fact, it is a form intermediate between the true Herrings (*Clupeina*) and the *Elopina* and *Chanina*; as it appears to be undescribed I propose for it the name—

THRISSOPATER.—Body oblong, compressed; abdomen compressed into an edge. Scales small, striated, adherent; lateral line indistinct. Snout conically pointed, with the jaws subequal in length; mouth very wide, both jaws with a series of small pointed teeth. Margin of the upper jaw formed by the maxillaries laterally, and by the inter-maxillaries mesially. Ventral fins opposite to, or behind, the posterior dorsal rays. Caudal fin forked; dorsal in the middle of the total length. A long axillary appendage, formed by scales, above the pectoral fin. Opercles and humeral arch dilated, smooth; cheeks covered by the posterior portion of the infra-orbital ring. Vertebræ about 50. Ova very small.

Thrissopater salmoneus.—The length of the head is contained $3\frac{1}{2}$ in the total length (without caudal fin), the greatest depth of the body, $4\frac{1}{2}$. Median line of the upper surface of the skull raised. Axillary appendage longer than pectoral fin. About 50 scales in a transverse line on the trunk in front of the dorsal fin. Dorsal fin opposite to the nineteenth to twenty-fifth vertebræ. Vertebræ, 48 or 49.

Locality.—The specimen was found in the lower part of the Gault at East Wear Bay, Folkestone; and is the property of James Reid, Esq., by whom it was kindly lent for description.

EXPLANATION OF PLATE I.

The full figure shows the left side of the fossil.
The separate view of the head is taken from the right side.
Fig. A. Axillary appendage of the right side.
a. Fragments of anal rays.
b. Two branchiostegals.
g. Impressions of the gill-laminæ.
n. Neural spine of antepenultimate vertebra.
o. Ovary.
so. Suboperculum.
sp. Supplementary bone of maxillary.
v. Ventral fin.
x. Undetermined granular mass.

ALBERT GÜNTHER.

British Museum.
July, 1870.

BRITISH FOSSILS.

DECADE XIII. PLATE II.

HETEROLEPIDOTUS LATUS.

[Genus HETEROLEPIDOTUS. EGERTON. (Sub-kingdom Vertebrata. Class Pisces. Order Ganoidei. Family Sauroidei.) Head large; snout obtusely conical; maxillary and mandibular bones straight; teeth of various sizes, the larger ones strong and bluntly pointed, the smaller ones sharp and numerous; gape wide; pectoral and ventral fins large; dorsal fin remote; scales large, thick and lustrous, more or less serrated on the posterior margins; abdominal scales small and elongated; tail broad, the upper lobe ridged, with strong fulcral scales.]

SYNONYM. *Lepidotus fimbriatus*, AGASSIZ.

THE genus *Lepidotus*, as defined by Professor Agassiz, is in the main composed of a natural and well characterized group of fishes, ranging from the chalk to the lias, both inclusive. It embraces, however, some aberrant forms assigned to it with doubt and hesitation, owing to the imperfect conditions of the specimens examined. Of these, *Lepidotus fimbriatus* from the lias of Lyme Regis, and *Lepidotus serrulatus* from the lias of Barrow-on-Soar, are two that come at present under consideration. The former name was given by Professor Agassiz to a specimen in the Museum at Munich, from Häring, in the Tyrol characterised by the uniformity of the scales. A second specimen, from the Keuper of Coburg, was referred to the same species; as well as a third from the lias of Lyme Regis, although the scales of the latter are described as offering some differences in size and form. He concludes by remarking that, "Des recherches "ultérieures devront apprendre positivement si je n'ai point "confondu ici des espèces différentés." * The fortunate acquisition of a fine series of specimens from the lias of Lyme Regis has enabled me to study the characters of these *Lepidoti* with great advantage, and I have ascertained two features in which they differ essentially from the typical *Lepidoti*, and approach the sauroid family *Eugnathus*. The first is the character of the teeth. In the true *Lepidoti* they are either large and

* "Poissons Fossiles," tom. ii., feuilleton 248.

rounded, like the tritoral teeth of the *Pycnodonti*, or obtusely conical and uniform in size, whereas in the species under consideration they are sharp and elongated, of various sizes, and very numerous. The other point of note is the form and arrangement of the scales. In all the typical *Lepidoti*, the scales are tolerably uniform in size, and those of the abdominal and ventral regions do not differ materially from those of the flanks. In the species under consideration the scales of the under part of the body become long and narrow, very like the similarly placed scales of the genus *Eugnathus*. This peculiarity is noticed by Agassiz in his description of *Lepidotus serrulatus*, for he says, "The scales do not preserve the same form over the "whole width of the body, they become more and more narrow "towards the ventral margin, where their width does not equal "one half of their length. This is a peculiarity very rare "amongst the *Lepidoti*, and serves to distinguish this species "from most of its congeners." * Pictet also remarks this fact, and, when speaking of *Lepidotus fimbriatus*, says, "This is a "species of which the generic position is still doubtful." Relying then upon these structural differences, I propose to group those species in which they obtain under a new genus, to which I had given the title *Eulepidotus*,† but, finding that Mons. Emile Sauvage has suggested this name for *Lepidotus Fittoni* (on what grounds I am at a loss to discover, since it is a typical *Lepidotus*), I have altered it to *Heterolepidotus*.

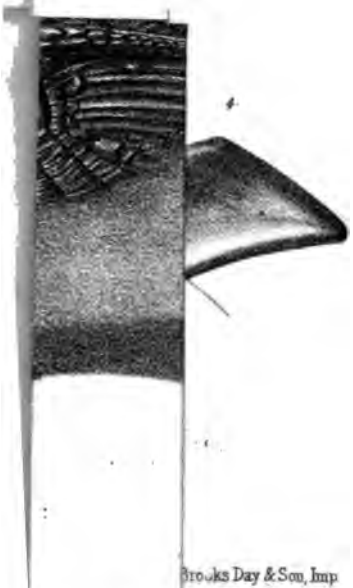
The specimens from Lyme Regis seen by Professor Agassiz, which he was induced with hesitation to refer to the same species as those he had previously examined from Häring and Coburg, were mere fragments, showing no characters except the form and sculpturing of the scales of the middle part of the trunk. In fact this fish was then considered one of the rarities of the lias. Now it is to be seen in most collections, many very fine, and some almost perfect specimens having been brought to light since the publication of the "Poissons Fossiles." Lord Enniskillen possesses a fine series, and my cabinet is also rich in specimens; but the finest example I have yet met with is in the British Museum. I have selected this for illustration (Pl. II.), and the details will also be taken from it, supplemented by the evidence of other specimens when necessary. I have seen specimens indicating a longer fish than the individual in the National Collection, but it may be taken as a fair average of the size of the species.

* "Poissons Fossiles," tom. ii., feuilleton 250.

† Quart. Journ. of the Geol. Soc., 1868, p. 503.

Description.—The length from the snout to the termination of the vertebral column is 21 inches. The head measures 5 inches from the premaxilla to the occiput, and 7½ inches from the premaxilla to the insertion of the pectoral fin. From the occiput to the insertion of the dorsal fin is 7 inches. The depth at the nape is 5 inches; from the dorsal to the ventral fin, 6½ inches; and the pedicle of the tail, 2½ inches. It will be seen by these measurements that the depth of the body equals nearly one-third of the length. In this respect it resembles the form of the true *Lepidoti*. Another similarity is found in the large size of the head, which is nearly one-third of the length of the body exclusive of the tail. The back and belly were both arched, and the muzzle rather bluntly rounded; but the thickness of the fish was not so great as would be expected from the other dimensions. The width between the orbits is only 1 inch, and the greatest width of the frontals behind the orbit barely two. The head is remarkable for the large size of the opercular apparatus, and the facial plates, especially those constituting the tympanic arch. The scapulo-coracoid arch is also powerful, and is farther consolidated by two broad plates immediately behind it, extending downwards to the attachment of the pectoral fin, resembling much in form and almost in size a secondary operculum and suboperculum. The maxillary bone is dentigerous, and the space between its upper edge and the orbit is covered by a broad infra-orbital plate. The mandible measures 3½ inches in length; both this and the maxilla are beset with numerous conical teeth of various dimensions. The entire head is invested with a beautiful lustrous enamel, having a surface more or less uneven on the different bones, the operculum having less ornament than some of the associated bones. The cranial details are very well preserved in a specimen I possess in a nodule of indurated lias. The operculum and suboperculum form a perfect half-circle, having a radius of $1\frac{8}{10}$ inch. The preoperculum is falciform, broader at the base than in the upper two-thirds; between this and the suboperculum there is a small inter-operculum, and sweeping along the lower margin of the inter-operculum and suboperculum three broad branchiostegous plates are preserved, extending as far upwards as the junction of the suboperculum with the operculum. The thoracic arch is strongly developed, and is covered externally with broad enamelled plates. It supports a pair of powerful pectoral fins. In the specimen in the British Museum the left pectoral fin is preserved. It contains 18 rays, the anterior one being much larger than the others, and having a delicate fringe along the margin.

The succeeding rays diminish in size as they recede from the head. The first ray is single throughout; the other rays are single for 1½ inch from their bases, and thence they are frequently divided and sub-divided, forming a delicate flexible organ capable of great expansion. The cross-joints are very numerous in the distal parts of the fin. The base of the fin is surrounded by a group of small massive polygonal scales, almost resembling a tesselated pavement (fig. 1 *a*). This peculiar character is also present at the insertion of the ventral fins. The latter fins are more powerful than in any ganoid fish with which I am acquainted. The first ray is very large, and has fulcral scales at its base, and a double set of marginal ossicles along the anterior edge. It contains nine other rays of corresponding power, similar in character to the pectoral rays. The dorsal fin is placed immediately above the ventral fins. It is composed of at least 20 rays, the fourth or fifth is the longest, and has a fringed margin. The anterior rays are rather fulcral scales than fin-rays. The fin is large, and together with the expanded ventral fins, and strong anal fin, constitutes an apparatus well adapted to enable so bulky a fish to maintain a vertical position in the water. The anal fin is not well preserved in the specimen figured, but I have it in another example of this species in my own collection. It is situate about half-way between the ventral fins and the commencement of the tail. It contains a dozen or more rays, shorter and thicker than those of the dorsal fin. The anterior ray has marginal ossicles; in this and the other characters this fin resembles the dorsal fin. The caudal fin measures 5½ inches across the lobes, and is powerfully constructed. The upper lobe is covered by an extension of the scales for some distance beyond the base; at the same time it is strictly a homocerque form. The upper edge of the fin is furnished with strong ridge scales, and similar scales extend a short distance along the inferior margin of the lower lobe. All the rays are cross-jointed at short intervals, and bifurcate near the distal extremities. The scales are more numerous and of smaller dimensions than those of Lepidotus. Those of the flanks are very uniform in size and shape. The upper and lower margins of the scales are slightly sigmoid and parallel in the anterior parts of the trunk. In the after parts they are straight, and the scales more oblique. Some of the anterior scales have the whole free margin serrated (Pl. II., fig. 2), and the surface of the scale striated. In other parts these ornaments are more restricted, and towards the tail cease altogether (Pl. II., fig. 4). The entire under surface of the body from the thoracic girdle to the anal



Brooks Day & Son, Imp

\ T U S.—

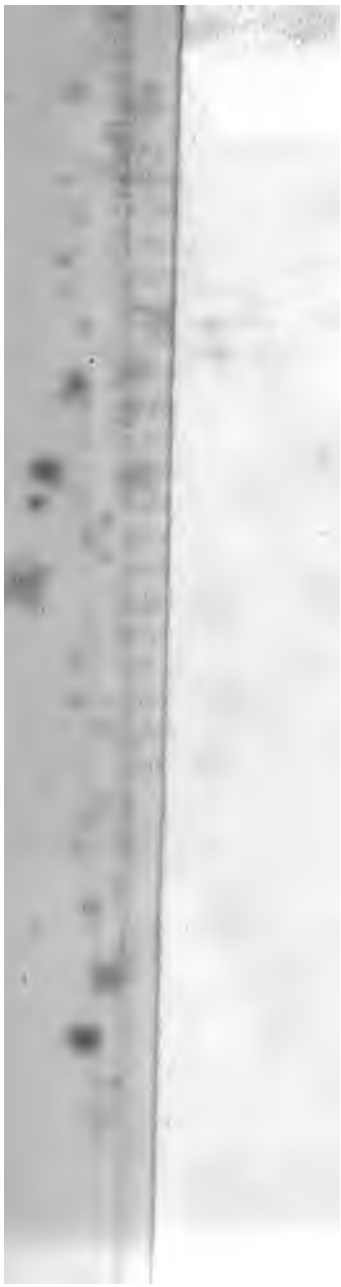
fin is covered with narrow elongated scales (fig. 1 *b*), very numerous, especially in the vicinity of the pectoral and ventral fins, a character never found in the type *Lepidoti*. The dorso-ventral series of scales are arranged in graceful double curves, the upper flexure in each being rather bolder than the sub-vertebral one Each series contains 29 or 30 scales, counting from the dorsal ridge to the commencement of the narrow abdominal scales. In *Lepidoptus gigas* and *semi-serratus* the number does not exceed 20. The lateral line runs nearly coincident with the vertebral column; it contains 56 scales (Pl. II., fig. 3). It traverses the seventeenth scale of the dorso-ventral rows, reckoning from the dorsal ridge. The scales of the sixth row are also perforated for mucous ducts, an arrangement that obtains also in *Dapedius*. The vertebral centra were in all probability well ossified, as the scaly armour is cracked along the region of the spine, an appearance that denotes a greater resistance to decomposition than would be the case were the column cartilaginous. The figure of the specimen of this fish in the British Museum has been exquisitely executed on stone by Mr. Dinkel, two-thirds of the size of nature.

EXPLANATION OF PLATE II.

Fig. 1. Heterolepidotus latus, reduced one-third.
Fig. 2. Scale from the shoulder, enlarged three times.
Fig. 3. Scale from the lateral line do.
Fig. 4. Scale from the tail do.
Fig. 5. Teeth magnified.

PH. DE M. GREY EGERTON.

Pectoral to ventral fins	-	-	0	$9\frac{1}{2}$	-	-	0	8
Ventral to anal fins	-	-	0	$4\frac{1}{2}$	-	-	wanting	



BRITISH FOSSILS.

DECADE XIII. PLATE III.

HETEROLEPIDOTUS SAUROIDES.

Heterolepidotus sauroides. SP. NOV.

THE two species of *Lepidotus*, alluded to in the foregoing article, differ considerably in form and proportions. *Lepidotus fimbriatus* is a short and deep fish, the trunk at its greatest expansion measuring one-third of the length from the nose to the base of the tail. The head occupies nearly one-third of the total length. *Lepidotus serrulatus*, on the other hand, is a long fusiform fish, the depth being two-sevenths and the head one-fourth of the length ("Poissons Fossiles," vol. ii., Pl. XXXI.). The subject of the following description resembles the latter in the proportion of the head to the trunk, but is a narrower fish, the depth being only one-fourth of the length. Several specimens of this species have been disintered at Lyme Regis in the last four years in very perfect condition, and many others which, although fragmentary, afford valuable information with reference to many details not so well shown in the larger specimens. They all appear to represent one and the same species, for although some slight differences are discoverable, they are not greater than might be expected to result from age, sex, or condition. I have selected two specimens for comparison: one belonging to Lord Enniskillen, the other to myself, the latter being the one represented in the plate (Pl. III., fig. 1). The following table gives the comparative measurements of the two.

	1		2	
	Feet.	inches.	Feet.	inches.
Length	2	2	2	0
Head	0	7	0	7
Nape to dorsal fin	0	7	0	8½
Dorsal fin	0	3½	0	3½
Dorsal fin to tail	0	9	0	9
Tail (imperfect)	0	4 (upper lobe wanting)	0	5
Pectoral to ventral fins	0	9½	0	8
Ventral to anal fins	0	4½	wanting	

	1 Feet.	inches.	2 Feet.	inches.
Anal fins to tail	0	7	wanting	
Depth of the shoulder	0	7½	0	6
Depth of the dorsal fin	0	7	—	
Depth behind the dorsal fin	0	6	0	5
Pedicle of the tail	0	3	0	3
Lower jaw	0	3	0	3½
The lower jaw of a third specimen	—		0	3¼

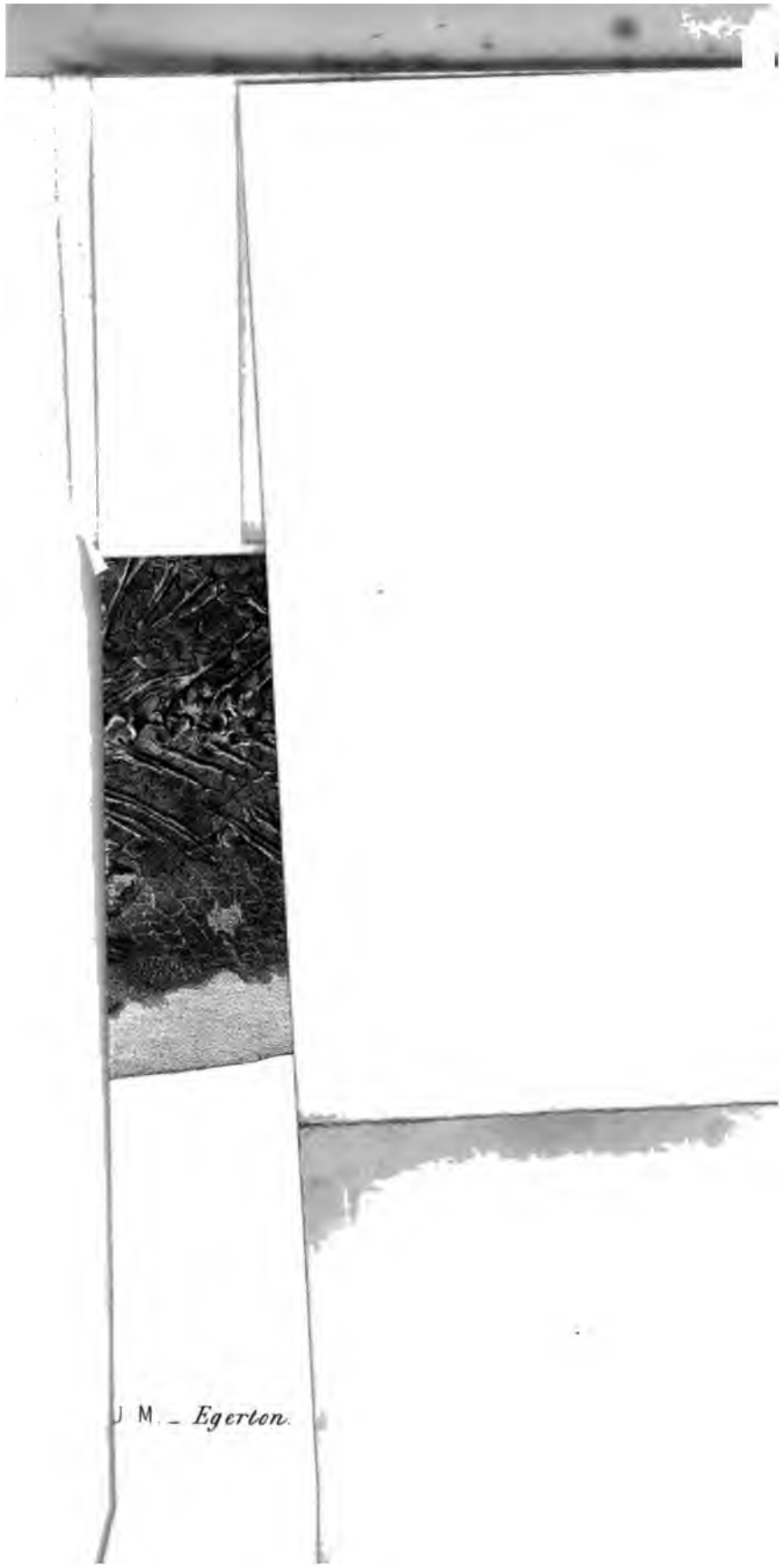
It will be seen from the foregoing measurements that the head is about one-fourth of the length exclusive of the caudal fin. The greatest depth of the body is at a point halfway between the occiput and the first ray of the dorsal fin, where it measures less than one-fourth of the length. From this point the body slopes gradually to the pedicle of the tail. The bones of the head are thick and strongly united, the orbits large. The premaxillary bones are short and carry a few strong prehensile teeth. The maxillary measures 2½ inches in length, and is armed with an outer row of laniary teeth and smaller teeth within. It is straight and expanded at the distal extremity where it overlaps the mandible. The lower jaw measures over 3 inches from the articulation to the symphysis. The mandibular teeth resemble those of the maxilla, but are rather larger (Pl. III., fig. 2). The lower jaw is characterised by great strength. It measures half an inch in depth at its median diameter, and expands into a broad plate posteriorly with a massive condyle for articulation with the hypotympanic bone. One specimen shows a series of 16 branchiostegal rays. The suborbital bones are large, covering the cheeks. The opercular apparatus is largely developed as well as the scapular arch. All these parts are plated with a thick layer of lustrous ganoine, having a course surface ornament of granules of the same substance, irregularly grouped on some of the bones and sparsely scattered on others. In other places, and notably on the opercular bones, the surface is smooth, but has an eroded appearance caused by very fine tortuous lines traversing the enamel in all directions. The pectoral fin has a strong attachment to the scapulo-coracoid bones. It is broad and long, measuring 4 inches in length. It contains about 20 rays, of which the first is very massive, the others are also strong and numerously divided as they recede from the base. The dorsal fin measures 3½ inches in height, and is situated over the ventral fins. It contains 20 rays, of which the sixth is the longest. It is preceded by five fulcral spines, and has a series of small marginal rays fringing the anterior edge of the fin. The ventral and anal fins are small.

The caudal fin is large and powerful. The upper lobe has a series of massive scales ridging the margin. It contains 18 long rays. The lower lobe has 20 rays, and is also invested with a set of fulcral rays along the lower margin. It is further strengthened by the extension of the body scales over the base in an oblique form, giving it a semi-heterocercal appearance. The scales on the median portion of the trunk resemble those of the typical *Lepidoti*, being trapezoidal on the anterior portion and rhomboidal on the after parts; but on approaching the insertions of the fins and along the abdominal and ventral regions of the body, they assume an elongated character, rapidly increasing in length and diminishing in width until they acquire the form of an elongated rhomb, having the larger diameter three times that of the other. This peculiarity is a constant character in the genus *Eugnathus*. A careful consideration of the foregoing details must lead to the conclusion that these forms can not be classified with the *Lepidoti*, nor can they be assigned to the family *Lepidoidei* to which the true *Lepidoti* belong. If we select a typical species of *Lepidotus*, we have a bulky form with a thick head, broad muzzle and restricted gape; the manducatory apparatus being composed either of tritoral teeth, resembling those of some of the *Pycnodonti*, or of stumpy conical teeth adapted for feeding upon shells, corals, or perhaps fucoids. The body is covered with large rhomboidal scales of pretty uniform size and closely rivetted together, and the fins are of moderate dimensions, not calculated for swift propulsion. The fishes described in this and the preceding article are furnished with teeth of two forms, like the recent *Lepidosteus*: the one for seizing the other for retaining the slippery prey, with strong pectoral fins for turning quickly in pursuit, and a powerful tail for rapid propulsion. In all these respects, as well as in the arrangement of the dermal armour, they agree with the genus *Eugnathus* rather than with *Lepidotus*, and consequently I do not hesitate to place them in the order *Sauroidei*.

EXPLANATION OF PLATE 3.

Fig. 1. Heterolepidotus sauroides, reduced one half.
Fig. 2. Part of the lower jaw, twice the size of nature.

PH. DE M. GREY EGERTON.



J M. _ *Egerton.*



BRITISH FOSSILS.

DECADE XIII. PLATE IV.

ISOCOLUM GRANULATUM.

[Genus ISOCOLUM.* EGERTON. (Sub-kingdom Vertebrata. Class Pisces. Order Ganoidei. Family Sauroidei.?) Body elliptic, symmetrical, narrowing forwards and backwards from the dorsal fin. Head small. Dorsal fin single in the centre of the back. Ventral fins under the dorsal. Vertebræ ossified. A set of interspinous bones not supporting dermal spines in advance of the dorsal fin. Scales sub-curvilinear uniformly granulated over the entire body.]

* Ἴσος, equal; κῶλον, member.

Isocolum granulatum, SP. UNICA.

THIS is another novelty from the rich storehouse of Lyme Regis. We are now cognisant of 31 genera, comprising 79 species of fossil fish, from this locality of the Lias formation. Of the former 13 genera have not as yet been found elsewhere, and of the latter not more than two or three species have been identified as being common to Lyme Regis and any other locality, British or foreign. As the beds of Lias limestone at Lyme Regis have been extensively worked for a long series of years, and as the shale beds are constantly exposed to the eroding action of the sea, we probably are in possession of a fair sample of the Fauna of the period, more especially since clever collectors have always been on the look-out since the days of Mary Anning, whose singular skill and perseverance added so many new forms to the repertory of fossil life. The numerical details given above would lead one at first sight to conclude that the theory of restricted habitats, so extensively worked out by Professor Agassiz on his recent visit to the river Amazon, was applicable to the fishes of Lyme Regis. Before, however, we can come to any such conclusion, we require more precise evidence as to the actual beds in which the several forms are found. The argument could only then be applied to the area of a single bed, as a few inches in vertical section might represent in geological time a period sufficient for an entire change in the inhabitants of the waters. There is every reason to believe

without the slightest curvature throughout. If a line were drawn at right angles to it, through the middle of the dorsal fin, the fish would be quartered into four equal and symmetrical parts. The pectoral fin was about 2¼ inches in length. It contains 12 rays. The first is peculiarly stout, and the articular facet is thickened out to the diameter of the articulations of the five succeeding rays. The rays extend 1½ inch before the commencement of the cross joints, and although flattened in their distal parts show no bifurcations. The dorsal fin consists of 16 rays, in addition to one or two fulcral rays, carried upon 17 interspinous bones. The front of the fin is bordered with raylets. The fifth ray is the longest, but the whole organ is small compared with the size of the body, in this respect resembling some of the *Pholidophori*. The rays are cross-jointed at a distance of 1 inch from the base, but not bifurcate. The ventral fins are attached to tolerably strong pelvic bones nearly 1 inch in length. The articular facets of these bones are thickened, the remainder is straight and flattened. The fins were large in comparison with the dorsal and anal fins, measuring 1¾ inch in length, and containing at least 12 rays. Unlike the component rays of the other fins these have a few bifurcations in the articulated region, which commence at 1 inch from the base. The anal fin is placed just half way between the ventral fins and the tail. It consists of 10 short rays, articulating with 10 long and slender interspines, the anterior one of the series being $1\frac{8}{10}$ inch in length. The only portion of the tail preserved consists of the bases of 12 rays of the lower lobe. They are articulated to the spatulate extremities of the caudal processes, and are very stout and cross-jointed. A set of fulcral scales bordered the lower margin of the fin. Judging from the characters thus displayed, it is fair to presume that the caudal fin was of considerable size and power, corresponding in these respects more with the Sauroid than with the Lepidoid family The scales (Pl. IV., fig. 2) are of medium size, those on the back, belly, and tail, being smaller than the others. Some have the upper margin concave, and the lower convex, some have the upper and lower angles rounded and some are more elongated than others. They are of considerable thickness, not so massive as the scales of *Lepidotus* and *Eugnathus*, but more so than the scales of *Pachycormus* and *Caturus*. In this respect, as also in the mode of attachment to each other, they most resemble the dermal characters of *Pholidophorus*. They are, however, very peculiar in having the surface ornament continued over the whole body. This consists of a combination of lines and gra-

nules of ganoine elegantly disposed in varying patterns, no two scales being in this respect exactly alike. Taking all these points into consideration, I have little doubt in considering *Isocolum* as a well-founded genus, although some uncertainty exists as to its family relations, and I shall anxiously look for further specimens to set this question at rest.

Explanation of Plate IV.

Fig. 1. Isocolum granulatum, reduced one-third.
Fig. 2. Scales magnified.

Ph. de M. Grey Egerton.

DECADE 13. PL. 5.

OSTEORACHIS.

(Oolitic)



"History," writes, "The embryonic form of the highest verte-
"brata recalls in its earlier stage the first representatives of its
"type in geological time, and its lowest representative at the
"present day." Now, although the Palæontologist is deprived of the means of tracing any one form of extinct life through all the phases of its development from the ovum to the perfect being, yet he is able to show, in following the succession of life from the earliest to the most recent of the fossiliferous strata, how certain embryomic characters have become permanent conditions by the arrest of development, beyond which no further progression is made during the existence of each particular type. In the class of fishes there are many remarkable instances of the permanence of embryomic structure, and none is more striking than the condition of the vertebral column, as regards segmentation and consolidation. In the embryo of every vertebrate animal the central axis is at one period "a more or less
"cylindrical fibrous sheath, filled with simple cells containing
"jelly" called the Chorda dorsalis, or Notochord. "The cen-
"trums or bodies of the vertebræ are developed in and from
"the notochord. The bases of the other elements are laid down
"in fibrous bands diverging from the notochord, and giving
"the first indication of the segmental character of the skeleton."*
These conditions of the vertebral column are represented from the earliest fishes of the Devonian period down to the present time, as seen in the lepidosiren, the lancelet, and the lamprey. In the sturgeons the notochord becomes cartilaginous, and in some of the Plagiostomi the segmentation of the column commences, and, together with the consolidation of the notochord, passes through a series of stages, until the complete vertebral form is obtained. The Teleostean fishes have the vertebral centres completely ossified, although in the embryomic condition they are notochordal. The hardening process is more rapid in the vertebral spines than in the centra, more especially in the neurapophyses; and Wagner and some continental Ichthyologists have taken generic characters from the forms of the proximal extremities of the vertebral spines in the notochordal fishes of the Pycnodont family. On applying this scale of development to the successive generations of fishes in the several geological periods, we find that in the Devonian strata most of the fishes are notochordal, the only exceptions being the genus *Tristychoptorus*, a fish remarkable for other bony characters, especially in the strong ossicles supporting the fins. In Dipterus, and some other genera, a certain amount of consolida-

* Owen's "Anatomy of the Vertebrates," pp. 30–31.

BRITISH FOSSILS.

DECADE XIII. PLATE V.

OSTEORACHIS MACROCEPHALUS.

[Genus OSTEORACHIS.* EGERTON. (Sub-kingdom Vertebrata. Class Pisces. Order Ganoidei. Family Sauroidei). Head very large; cranial bones massive; teeth numerous, thronging all the bones of the mouth; pectoral fins very large; ventral fins with strong pelvic bones; dorsal fin over the ventrals; vertebræ massive, ossified; scales coarsely ornamented.]

* *ὀστέον*, bone; *ῥάχις*, spine.

Osteorachis macrocephalus. SP. UNICA.

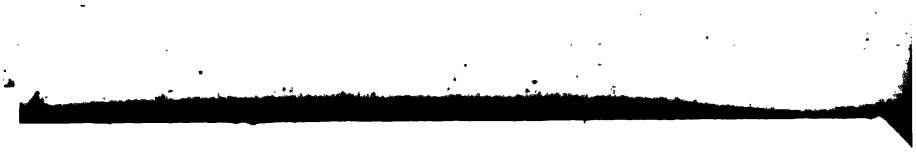
THE student of Palæontology labours under many and great disadvantages in pursuing his inquiries, as compared with those who are engaged in the examination of recent structures. The materials with which he has to deal are necessarily imperfect, owing to the decomposition of the soft parts; and many of the other parts, which may have been enabled to resist decay, have become intractable through the substitution of some harder material for that of which they originally consisted. The most perfect specimens show, for the most part, only the external form of the animal, the internal parts being hidden or absent; or perhaps the internal hard parts may be preserved without a trace of their outward covering. But although these are great hindrances to the attainment of a clear knowledge of the structure and affinities of extinct forms, a far more serious obstacle intervenes in the negation of all assistance from the study of the embryology and development more especially of the higher classes of animal life found in the strata of the earth. Embryology and development are to the Palæontologist, as regards his special study, a sealed book; and all he can do is to avail himself of the light thrown upon his subject by the investigations of others as regards these recent forms most nearly allied to those he has to deal with. But while he borrows this light from his biological fellow-labourer, he is able to reflect some rays of knowledge in return, with respect to the general application of these subjects to geological time. Professor Agassiz, in his charming little volume on "Methods of Study in Natural

teeth, larger than those of the mandibles. The outer surface of the head bones is roughly ornamented with irregular pimples and blisters of enamel, and the inner plate of those not carrying teeth has a shagreen-like appearance. The vertebral column contains from 40 to 43 vertebræ, completely ossified, measuring half an inch each in diameter. The neurapophyses are proportionately solid, and are attached to the centres by broad articulations; indeed, the whole of the vertebral apparatus is of unusual strength and size. In accordance with the large dimensions of the head, we find the pectoral fins greatly developed. The fin rays are strong and cylindrical. They measure 1¾ inch in length before they bifurcate. From the bifurcations the rays are frequently subdivided, and closely jointed. The ventral fins are composed of about eight rays each. The first is flattened, the others are cylindrical. They are simple for 1 inch from the pelvic attachment, and thence traversed by numerous cross joints. The pelvic bones are strong and spatulate. The dorsal fin is placed over the ventrals, the anterior ray being slightly behind the proximate end of those fins. It is carried on a set of long and strong interneural spines, but the fin itself is of moderate size. It has no fulcral or marginal rays, and contains but few fin rays, arranged at rather distant intervals. The anal fin is near the tail. It contains seven or eight rays. The dermal covering is in conformity with the other characters of the fish, being of great solidity. The scales are large and thick, oblong in form, with the posterior edges slightly rounded. They are firmly socketted together by means of a strong pin fitted into a deep notch in the adjoining scale. The overlap is considerable, giving additional strength to the coat of mail. The layer of ganoine on the surface of its scales is dense and lustrous, and is ornamented with blisters or tubercules, coarse and numerous on the anterior scales, but smaller and more distinct near the tail. In one of the specimens a few scales are seen, between the nape and the dorsal fin, having fine striæ on the surface, terminating in a slightly dentate margin. These characters are not discernible on the other specimen; they may be due to age, as they occur in the larger specimen. As the two specimens agree in all other respects, I am loath to consider them of specific significance. This genus belongs to the Sauroid family of the order Ganoidei.

EXPLANATION OF PLATE V.

Fig. 1. Osteorachis macrocephalus, reduced one-third.

PH. DE M. GREY EGERTON.







BRITISH FOSSILS.

DECADE XIII. PLATE VI.

PLATYSIAGUM SCLEROCEPHALUM.

[Genus PLATYSIAGUM. EGERTON. (Sub-kingdom Vertebrata. Class Pisces. Order Ganoidei. Family Sauroidei.) Head large; body tapering; maxilla expanding posteriorly into a broad vertical plate; dentary portion curved upwards; mandible with a broad coronoid process; large liannary teeth on both jaws with numerous smaller teeth in the interspaces, and investing the whole interior of the mouth; head bones rough; pectoral fins large, the front rays covered with spiculæ; ventral fins very remote; scales small and thick with striæ and granules on the surface.]

* πλατὺς, broad; σιαγὼν, the cheek.

Platysiagum sclerocephalum, SP. UNICA.

THE rich cabinet of fossil fishes, collected by Miss Philpot from the Lias of Lyme Regis, contained a single specimen of a fish referred to the genus *Eugnathus*, which was named by Professor Agassiz *Eugnathus polyodon*.* Subsequently he found in the collection of Lord Enniskillen two fragments of jaws which he doubtfully assigned to the same species. He was, however, by no means satisfied to leave the matter in doubt, for in the last letter I received from him before he left England in 1840, he says "Les mâchoires d'Eugnathus polyodon sont "elles justes?" For nearly 30 years that question has remained unanswered. A few specimens have been found from time to time clearly belonging to the same species, which have been carefully stored by Lord Enniskillen and myself, but none sufficiently good to solve the enigma. So lately as last year, I was inclined to think that they might have belonged to the new genus *Osteorachis*, to which they had a closer resemblance than to the genus *Eugnathus*; but more recently two specimens have been found linking together the scattered fragments we had previously obtained, and exhibiting all the principal features of this remarkable fish. The evidence thus fortunately brought to light proves that this fish cannot be classified with *Eugnathus* or any other known genus, although its affinities are with the

* "Poissons Fossiles," tom. ii. 2, feuilleton 104, tab. 58*a*, fig. 2.

whole dermal surface. All the scales are marked with radiating lines on the exposed part, terminating in a pectinate border at the free extremity.

The foregoing details show that in every respect this must have been a predaceous fish, furnished with every requisite structure for speed and rapine; a most formidable enemy to the shoals of *Pholidophori*, and other small fish which abounded in the Liassic sea.

EXPLANATION OF PLATE VI.

Fig. 1. Platysiagum sclerocephalum, size of nature.
Fig. 2. Head of ditto.
Fig. 3. Portion of jaws, the size of nature.
Fig. 4. Conical teeth, magnified.

PH. DE M. GREY EGERTON.



BRITISH FOSSILS.

DECADE XIII. PLATE VII.

PALÆOSPINAX PRISCUS.

[Genus PALÆOSPINAX. EGERTON. (Sub-kingdom Vertebrata. Class Pisces. Order Placoidei. Family Spinacidæ.) Body elongated; vertebræ very numerous; two dorsal fins each bearing a spine; oral aperture inferior; maxillary teeth multicuspid, longitudinally ridged; mandibular teeth tricuspid, smooth; skin coarsely granulated.]

Palæospinax priscus. SP. UNICA.
SYNONOMY. *Thyellina prisca*, AGASSIZ.

THE generic title *Thyellina* was given by the late Count Münster to a specimen of a small squale found in the chalk formation of Baumberg near Münster. He did not publish it, but submitted it to the consideration of Professor Agassiz, then engaged upon his great work on Fossil Ichthyology, who sanctioned the name and assigned the genus to the family of the *Scylliadæ*. About the same time Professor Agassiz discovered, in the collection of Miss Philpot, a chain of vertebræ from the Lias of Lyme Regis which so far resembled the vertebral column of *Thyellina angusta*, Münster, that in the absence of more characteristic specimens he included it in the same genus, with the specific name *Thyellina prisca*. He guarded himself by saying, that seeing no traces of fins he could not pronounce a definite opinion as to the true affinities of this fish, which might possibly prove to be the type of a new genus.* Many years elapsed before any other evidence was obtained as to the true characters of this rare fish. At last Lord Enniskillen acquired a specimen showing the head and the anterior portion of the vertebral column (Pl. VII., fig. 1), and this disclosed the fact that the first dorsal fin carried a spine somewhat similar to that of the recent *Spinacidæ*. Two other specimens were discovered shortly afterwards, which proved that the second dorsal fin also bore a spine. It became evident, therefore, that the Lias species could not belong to the genus *Thyellina* which has no dorsal spines, nor to the family *Scylliadæ*, but ought to be removed to the family *Spinacidæ*, and form, as Professor Agassiz foreshadowed,

* "Poissons Fossiles," tom. iii., feuill. 379, tab. 29, figs. 1, 2.

the type of a new genus, more nearly allied to the genus *Acanthius* than to any other form recent or fossil.

Description.—The specimen (Pl. VII., fig. 1), which afforded the clue to the true character of this fish, measures 5½ inches in length. From the anterior margin of the upper jaw to the articulation of the first vertebræ, with the occiput, is $1\frac{7}{10}$ inch, and to the insertion of the first dorsal spine nearly 4 inches. The vertebral column is broken 1½ inch behind the dorsal spine. It contains 24 vertebræ, of which the fourteenth and fifteenth subtend the spine. A second specimen has 85 vertebræ, but is imperfect at both ends. It shows one spine which from its position in the column must be the second dorsal, there being 40 vertebræ in advance of it. Another specimen, imperfect at both ends, has 36 vertebræ, and a spine which must also be a second dorsal, as there are 29 vertebræ in advance of it. With this specimen was found another spine, said to have belonged to it when first found, which, if this be true, will be the first dorsal of the same individual (Pl. VII., figs. 3–3*a*). The lower jaw is well shown upon another specimen (Pl. VII., fig. 2), most probably belonging to the same species. All these remains are derived from fish of about the same size, and that (judging from the properties of the vertebræ) about one-third smaller than the average size of the recent *Spinax acanthias*. The anterior contour of the upper jaw, as seen from below, is semicircular; the extremities of the semicircle are thence extended backwards, slightly diverging and sweeping outwards as they approach the articular processes. The dentigerous portion is 1½ inch in length, the total length from the symphysis to the condyle being $2\frac{3}{10}$ inches. The breadth of the palate is ½ inch in front and 1 inch at the base. The teeth have a median acuminate cusp, flanked on either side the base with one or more small cusps (Pl. VII., figs. 4, 5, 6). They are slightly recurved, and are ornamented with delicate raised lines extending upwards from the base, very much resembling the teeth of some small *Hybodus*. They vary in form according to position, the anterior teeth being more elongated than the lateral ones. The posterior part of the upper jaw cartilage is ½ inch in breadth, and the condyle is thick and rounded for the attachment of the mandibular cartilages. The lower jaws, as seen in another specimen (Pl. VII., fig. 2), measure 2 inches in length, and ½ inch in depth at the greatest diameter. The teeth differ from those in the upper jaw by the principal cusp being more slender and the lateral cusps and ornamentation nearly obsolete (Pl. VII., figs. 7, 7*a*, 8). The vertebræ seem to have been very numerous. In the specimen figured by Agassiz, there are 98, and the anterior part of the column is wanting. In

one of Lord Enniskillen's specimens, imperfect at both ends, there are 85. The total number when complete must have been considerably greater than in the column of *Spinax acanthias*, which contains 108 to the extreme point of the caudal fin. The characters of the vertebræ have already been described and figured in the "Poissons Fossiles." The position of the first dorsal spine was nearer the head then in the recent form. In the latter it is situated over the twenty-fourth and twenty-fifth vertebræ, and in the former over the fourteenth and fifteenth. The place of the second dorsal spine cannot be ascertained, as no specimen has yet been found having the two dorsal spines *in situ*. In the recent *Spinax* it is over the fifty-eighth vertebra. As to the characters of the spine, the posterior one appears to have been the longest, but little difference is perceptible in the form and proportions of the two. The exposed part resembles the corresponding portion of the spine of *Spinax acanthias*, in being marked with lines of growth, and in the absence of a quillet on the anterior margin; the base however, or that portion enveloped by the membrane, differs remarkably, in being deeply striated longitudinally and beset with small tubercles, very much resembling in this respect a dorsal spine of a small *Asteracanthus*. It will be readily seen from the foregoing description that those remains, although apparently belonging to a member of the family *Spinacidæ*, differ nevertheless from the genera *Acanthias* and *Spinax* in many particulars, notably in the characters of the teeth and the position of the first dorsal fin. I have therefore elected a generic name denoting the affinities of the genus, and have retained the specific appellation given by Professor Agassiz.

The specimens which have furnished the materials for the foregoing description were all found in the Lias at Lyme Regis, and are the property of the Earl of Enniskillen. I have a chain of vertebræ and some scattered teeth from the Lias of Würtemberg, which much resemble those of *Palæospinax*, but the materials are too imperfect to justify such a classification.

EXPLANATION OF PLATE VII.

Fig. 1. Palæospinax priscus, size of nature.
Fig. 2. Head of ditto ditto.
Fig. 3. 1st dorsal spine.
Fig. 3*a*. The same magnified.
Fig. 4. Tooth of upper jaw, outside view, magnified.
Fig. 5. Posterior tooth of upper jaw magnified.
Fig. 6. Front tooth of upper jaw, outside view, magnified.
Fig. 7. Tooth of lower jaw, outside view, magnified.
Fig. 7*a*. Same tooth, inside view, magnified.
Fig. 8. Posterior tooth, lower jaw, magnified.

PH. DE M. GREY EGERTON.



Geological

DECADE 13 Pl 8

SEMIONOTUS.

(Oolitic)



Jos Dinkel lith

Vincent Brooks Day & Son, Imp

BRITISH FOSSILS.

DECADE XIII. PLATE VIII.

SEMIONOTUS MANSELII.

[Genus SEMIONOTUS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. Family Lepidostei. Sub-family Lepidostei homocerci.) Body short and deep, intermediate between Dapedius and Lepidotus; scales rhombiform, thickly covered with ganoine. teeth in several rows; dorsal fin extending from the middle of the body to a point above the anal fin; caudal fin large, the upper lobe bearing ridge scales; homocerque. All the fins furnished with fulcral rays.]

Semionotus Manselii, SP. NOV.

ALTHOUGH the subject of this memoir is represented by a very imperfect specimen, I have nevertheless selected it for a place in this decade in consideration of the extreme rarity of remains of fossil fishes in the Kimmeridge clay as developed in this country. The only species described by Agassiz from our English strata of this age are, *Asteracanthus ornatissimus*, *Strophodus reticulatus* (the latter being in all probability the dental apparatus of the former), *Hybodus acutus* and *leptodus* (two small Ichthyodorulites), *Chimæra* (*Ichyodus*) *Egertoni*, and *Sphærodus gigas*, the last named being the only representative of the Ganoid order.

In the period that has elapsed since the publication of the "Poissons Fossiles," only two species have been added to the list: one a Cælacanth (*Macropoma substriolatum*), alluded to by myself in the Tenth Decade, page 19, note, and subsequently described and figured by Professor Huxley, in the Twelfth Decade, page 39, Plates IX., X., from the Kimmeridge clay of Cottenham; the other, a Pycnodont, *Gyrodus coccoderma*, from the Kimmeridge clay of Kimmeridge, described by myself in the twenty-fifth volume of the Quarterly Journal of the Geological Society of London, page 383. It appears hence that the knowledge we possess of the Ichthyic fauna of our Kimmeridge zone is restricted to four, or at most five, Placoid, two Pycnodont, and one Cælacanthoid species. In this paucity of evidence the discovery of a member of the Lepidoid family is a step in

advance, and consequently of greater interest to Palæontologists than better preserved specimens from richer deposits.

The genus *Semionotus* was established by Agassiz for the reception of some forms of fossil fishes intermediate between the genera *Dapedius* and *Lepidotus*, differing from the former in the fusiform outline of the body, from the latter in having a prolonged dorsal fin, and from both in the dentition. The type species is *Semionotus leptocephalus*, from the Lias of Boll, in Würtemberg. Ten other species have been described from various localities, but all probably from the Lias formation, the sole British representative being *Semionotus rhombifer* from the lias of Lyme Regis, and even this has more affinity with the genus *Heterolepidotus* than with *Semionotus*.

Description.—The only specimens I am acquainted with of this fish were purchased at Wareham many years ago by Lord Enniskillen and myself. They were said to have been found in the Kimmeridge clay beds of the Isle of Purbeck. The fragments had all the appearance of having belonged to the same specimen, and by a little careful adjustment produced the result figured in the accompanying plate, No. 8. The only liberty taken with the original is the reversal of the tail in the drawing, the portion of the matrix containing it having belonged to the counterpart of the remainder. The head and all the anterior parts, as far as the commencement of the dorsal and ventral fins, are wanting. The length of what remains is 1 foot, exclusive of the caudal fin. The depth from the anterior ray of the dorsal fin to that of the ventral fin is 6½ inches. The dorsal fin commences slightly in advance of the insertion of the ventral fin, and extends beyond the anal fin. It measures 4 inches in length. The constituent rays are over 30 in number, exclusive of the fulcral rays. The length of the rays is not seen, but judging from the strength of the anterior rays, and from the analogy of other species of the genus, it must have been considerable. These rays are single for 1 inch of the extent, at which point the cross-joints commence, and are very numerous. The fulcral scales in front of the fin are strong and progressive in length as they ascend the base of the fin. There is also a neat border of marginal scales in this and all the other fins. The ventral fins contain but few rays, but those are of considerable length. The fins are of medium size. The anal fin contains 12 rays, and has a marginal enrichment corresponding to that on the other fins. The lower lobe of the caudal fin is absent. The upper lobe is 4 inches in length, the extremity being imperfect. It contains 14 rays, having frequent cross-joints and fimbriated extremities. The

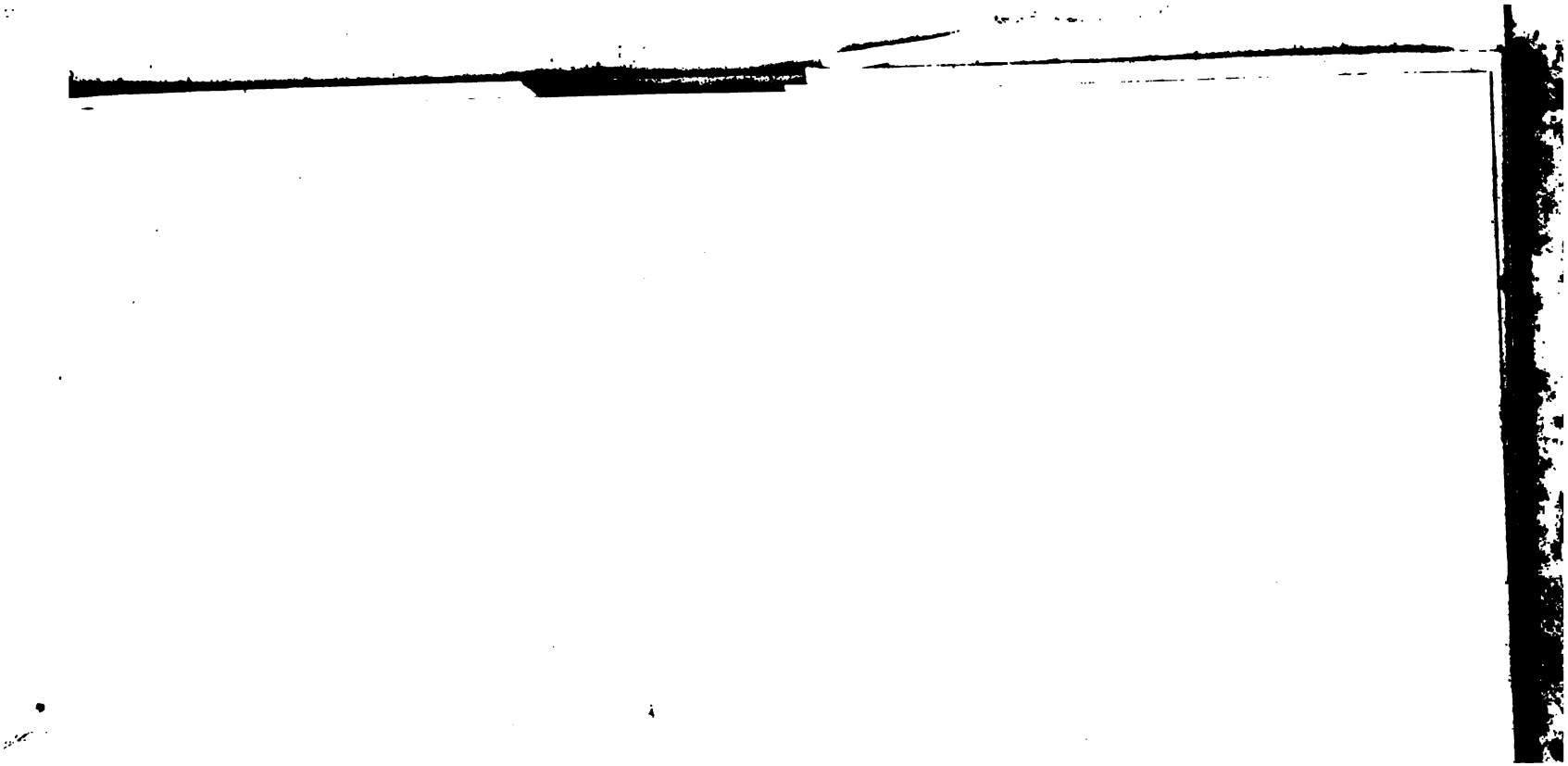
upper edge is furnished with a series of strong imbricated ridge scales, and this feature, combined with a scaly projection at the base of the fin, gives a semi-heterocerque character to the tail. It is, however, truly homocerque. The scales are smooth and rhomboidal; nearly equilateral on the anterior parts of the trunk, but becoming more elongated in the after part. The free edges are distinctly serrated over a considerable portion of the trunk, but become less so behind the dorsal fin. The dorso-ventral series, commencing at the insertion of the dorsal fin, contains 30 scales. All the scales have a thick exterior layer of lustrous ganoine.

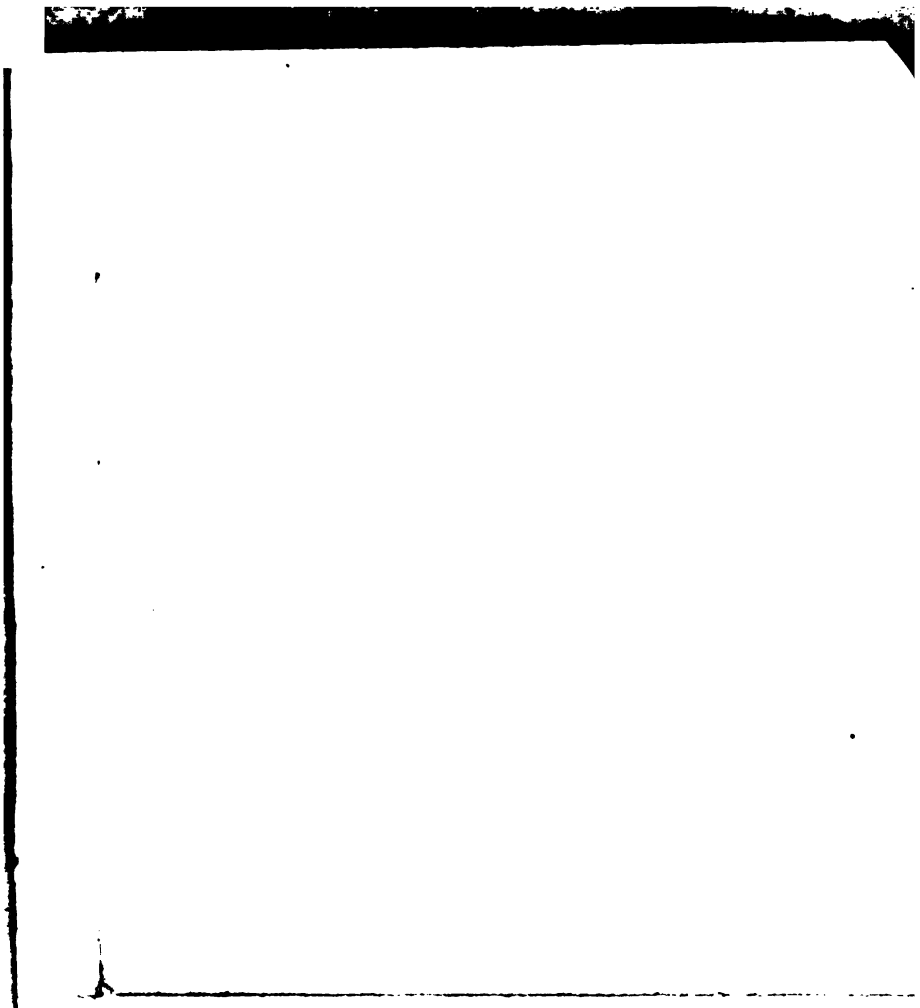
This is the largest species of the genus yet described; when perfect it probably measured 22 inches from the snout to the extremity of the tail. I have named this species after Mr. Mansel, of Longthorns, near Blandford, who has devoted much attention to the fossils of the Kimmeridge clay of his neighbourhood, and to whose liberality the Jermyn Street Museum is indebted for many interesting specimens.

EXPLANATION OF PLATE VIII.

Semionotus Manselii, reduced one-half.

PH. DE M. GREY EGERTON.





BRITISH FOSSILS.

DECADE XIII. PLATE IX.

DREPANEPHORUS CANALICULATUS.

enus DREPANEPHORUS. EGERTON. (δρεπάνη, a sickle; φέρω, to bear). kingdom Vertebrata. Class Pisces. Order Placoidei. Family Cestraciontidæ.) of two forms; the anterior rows cuspid, the lateral rows tritoral; two l spines,—1st, smooth and sickle-shaped, recurved; 2nd, slightly recurved, er than the first.

NONYMS. *Spinax major*, AGASSIZ, "Poissons Fossiles," tom. iii., leton 62, tab. 10ᵇ, figs. 8–14. *Cestracion canaliculatus*, EGERTON. ON, "Fossils of Sussex," page 365, Pl. XXXII., figs. 8–8*a*.

the "Fossils of the South Downs," published in 1822, Mantell gives representations in Pl. XXXIII., figs. 5, 6, wo spines found in the Upper Chalk, near Lewes, which lescribes as follows in the text, page 229: "The specimen lineated in fig. 5 is evidently the defence of a fish, and so rikingly resembles the spine fixed between the eyes of certain ecies of Balistes that there can be no hesitation in con- lering it as belonging to a fish of that genus. It is of a rk chocolate colour, and possesses a fine polish. Several rtebræ are imbedded in the chalk near its base. Fig. 6 is arly allied to the preceding, but in all probability is referable a different species of the same genus." When Professor ssiz examined those specimens in Dr. Mantell's collection, ecognised the affinity they have to the Plagiostomous fishes, notably to the *Spinacidæ* of the recent seas, and considered n as probably the spines of the anterior and posterior dorsal of the same species which he named *Spinax major*. The e specimens were again figured in the "Poissons Fossiles," 10ᵇ, figs. 11–14. When the late Mr. Dixon was engaged ne preparation of his work on the "Geology and Fossils of e Tertiary and Cretaceous Formations of Sussex," I assisted in the descriptions of the fossil fishes, and amongst others scribed a specimen belonging to the late Marquis of North- ton, containing some scattered teeth so much resembling e of the *Cestracion Philippi* of the recent fauna, that, in the

absence of more decisive evidence, I assigned them to that genus, with the specific name of *C. canaliculatus*, in relation to the most striking feature in which they differed from those of the recent *Cestracion* (Pl. IX., figs. 3–4).* Some time after the publication of Mr. Dixon's work, I found in the collection of Mr. Henry Catt (now Willett), of Brighton, a specimen which to my great surprise proved that *Spinax major*, of Agassiz, and *Cestracion canaliculatus mihi*, were one and the same species (Pl. IX., fig. 1). I gave a short note of this discovery in the Proceedings of the Geological Society for 1853, page 281. About the same time I saw in the collection of Mr. Charles Potter, of Lewes (now of Liverpool), a fine head of the same species, and two very perfect spines said to have belonged to the same individual. More recently Mr. Capron, of Guildford, has kindly placed at my disposal for description a vertebral column having the two spines *in situ* (Pl. IX., fig. 2), and a head of the same species, but not derived (I believe) from the same individual. Through the kind intervention of Mr. Willett, the custodians of the Brighton Museum (to which institution Mr. Willett had presented his valuable collection) have generously allowed me the use of their specimen for the illustration of this article. As this is the only specimen hitherto found having the head and spines unequivocally connected, I proceed to describe it, in the first instance, as the clue to the other specimens enumerated above. When I first saw it the head was overlaid by the tail of a large *Macropoma* lying nearly at right angles to the *Spinax* and concealing the greater part of the lower jaws. This incumbrance has been most dexterously dissected away by Mr. Willett, and the specimen thereby very much improved. The hinder part of the body from the second dorsal spine is wanting in this specimen, and also in Mr. Copron's. The parts preserved measure 15 inches from the muzzle to the posterior edge of the second dorsal spine. From the nose to the anterior edge of the first dorsal spine it measures 9½ inches, and from the latter point to the anterior edge of the second dorsal spine is 5 inches. The position of the head is such that the upper surface of the cranial box is concealed by the matrix. The interior of the mouth is displayed and the rami of the lower jaw; the length from the front of the maxilla to the hinder extremity of the mandible is 3 inches. The anterior portion of the vertebral column was concealed by the matrix, but through the careful dissection of Mr. Davis, of the British Museum, 24 vertebræ are displayed in advance of the first dorsal fin spine.

* XXXII., fig. 8, Dixon.

In the recent *Cestracion Philippi* there are only 14 vertebræ between the skull and the first dorsal spine (a like number occurs in *Palæospinax*), and in *Acanthias* 24. From the first to the second dorsal spine there are 24 vertebræ in the fossil, while there are 32 in the recent *Cestracion*, and 34 in *Acanthias*. There is a remarkable diminution in the size of the vertebral centres midway between the first and second dorsal spines, where they rather abruptly decrease from three to two lines in length, with a corresponding decrease in diameter, defining the commencement of the series of caudal vertebræ. A similar structure obtains in the recent *Acanthias*, but at a more distant point, namely, two-thirds of the space between the first and second dorsal spines. The first dorsal spine measures 3 inches in length, of which the base or insertion occupies $1\frac{1}{10}$ inch. The form of the spine is falcate. The exserted portion has a smooth external covering, faintly marked by longitudinal and transverse lines. It has no quillet on the front, but a deep groove the entire length of the back. The lower extremity measures half an inch in antero-posterior diameter. The second dorsal spine in Mr. Potter's specimen measures $2\frac{1}{2}$ inches in length. It is straighter and narrower than the first dorsal, but in other respects resembles it. It is presumable that both these spines supported fins, and some traces of shagreen are seen in the specimens in the vicinity of the spines, but no evidence remains of the size and shape of these appendages, further than that they embraced much less of the spines than in any of the recent spine-bearing Placoids.

The form of the head is rather broader and less prognathic than in *Cestracion*. The lower jaw in the Brighton specimen measures 2 inches in length by $\frac{3}{4}$ inch in depth at its greatest diameter. Mr. Potter's specimen belonged to a larger individual, the corresponding dimensions being $3\frac{1}{4}$ inches and $1\frac{1}{4}$. The upper jaw is slightly longer, but not so deep. The teeth were of two distinct types, as in the recent *Cestracion*, the anterior series being prehensile (Pl. IX., fig. 5), the posterior tritoral (Pl. IX., fig. 6). The former are cuspidate, some having a principal and two lateral cusps, others being unicuspid. This difference probably arises from age and use. The arrangement of the posterior or molar teeth is in parallel oblique ranks. In the recent fish the centre rank is composed of larger teeth than the preceding and succeeding rows, but in the fossil form (as seen in Lord Northampton's specimen (Pl. IV., fig. 3); there are two sets of large teeth, with a row of smaller teeth between the succeeding rows decreasing in size forwards and backwards

as in *Cestracion*. The form of the teeth more nearly resembles that of some of the *Acrodi*, while in the recent *Cestracion* it is more like that of *Strophodus* (Pl. IX., fig. 1). In comparison with the recent teeth the fossil teeth are longer and narrower, the surface is more deeply sculptured, and the umbo more elevated. A central ridge traverses each tooth, rising to an apex near the middle, and from this ridge parallel grooves interspersed with pits extend downwards to the base of the tooth, the declivity of the inner side being more abrupt than the other. On comparing these teeth with the forms of fossil acrodont fishes, they have the greatest resemblance to those of *Lophodus Keuperinus* found in the Keuper beds of Worcestershire. A very peculiar character is found on the under surface of these teeth, to which I directed attention in the work of the late Mr. Dixon on the "Geology and Fossils of Sussex," and which suggested the specific name I then adopted. The base of each tooth is traversed by a large tube, which, when the teeth are in juxta-position, forms a continuous canal through the whole of each series (Pl. IX., fig. 4). The margin of one aperture in each tooth is produced and corresponds to a depression on the adjoining tooth, a mechanism very similar to that found in the articulations of the scales in some of the ganoid fishes. In the recent *Cestracion* the teeth are perforated by several canals, irregular both in size and position (Pl. IX., fig. 7), traversing the basal portion at right angles to the longer diameter of the tooth. Taking into consideration the structural divergencies of this extinct fish from the recent *Acanthias* and *Cestracion*, I feel justified in proposing for it a new generic term, expressing the singular form of the dorsal spine. This fish probably attained a large size, judging from the specimen figured in "Poissons Fossiles," vol. iii. tab. 10*b*, figs. 12–13.

EXPLANATION OF PLATE IX.

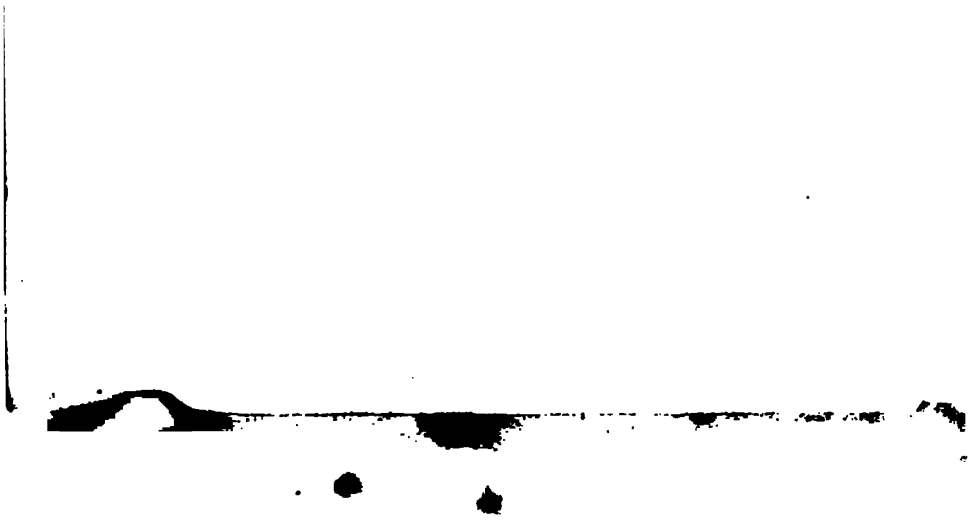
Fig. 1. Drepanephorus canaliculatus, size of nature.			Brighton Museum.
Fig. 2.	Ditto	ditto.	Mr. Capron.
Fig. 3, 4.	Ditto	ditto.	Lord Northampton.

Fig. 5. Front teeth magnified.
Fig. 6. Tritorial teeth, magnified.
Fig. 7. Tritor of Cestracion Philippi, magnified.

PH. DE M. GREY EGERTON.

ADE 13. PL 10.
OPHAGUS.





BRITISH FOSSILS.

DECADE XIII. PLATE X.

HOLOPHAGUS GULO.

THE specimen in the Museum of Practical Geology, upon which the genus *Holophagus* was founded (Decade XII., p. 26, Pl. VI.), lacks the head and the pectoral fins; but, by the kindness of the Earl of Enniskillen I am enabled to supply this deficiency, and to figure the very fine, and almost entire, example of the genus represented in Pl. X., of one-half the size of nature.*

The parts of the body which can be compared show the entire concordance of this specimen with the type.

In addition, the characteristically ossified air-bladder is well displayed, a few short ribs lying above its posterior third.

Between the ventral and the anal fins there lies a strong forked bone, which seems to have supported the anal fin. In its general form, and in the configuration of its constituent bones, so far as they admit of comparison, the skull is extremely like that of *Macropoma*, and, as in the latter fish, the ornamentation consists of dots of enamel. Indeed, it is hard to say by what character, except the greater extent to which the dorsal fin rays are articulated, *Holophagus* is distinguishable from *Macropoma*.

As the figure shows, there is an appearance as if ossified vertebral centra were developed in the most anterior part of the spinal column. What the elevations thus represented really are, it is not easy to say, but comparison with the thickness of the notochord will show that they are not nearly large enough for true centra.

The specimen figured could not, when entire, have been less than 30 inches long. The head, from the occiput to the snout, measured about 7 inches. It was obtained from the Lias of Lyme Regis.

T. H. HUXLEY.

* As the drawing has not been reversed, it is the right side of the fish which is depicted.

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